User Guide

ML2439A Power Meter

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Chapter 1 — General Information

1-1 Introduction

This user guide provides the installation and the operation of the Anritsu ML2439A Power Meter. The ML2439A provides the utility of traditional benchtop instruments, the flexibility and performance of Anritsu MA241xxA, MA242xxA, MA243xxA and MA244xxA power sensors.

As a benchtop meter, the ML2439A provides a standalone solution for capturing, displaying, and analyzing CW, RMS, Peak and average RF power in both the time and statistical domains through a touch screen display.

The ML2439A provides four Anritsu USB Power Sensors ports in the front panel and four in the rear panel with industry-leading performance and capabilities independently for CW, modulated, and pulsed signal measurements. Additionally, synchronized multi-channel measurements can be made between USB ports of pulsed signals.

Additional Documentation

Visit the product website for additional information:

https://www.anritsu.com/en-us/test-measurement/products/ml2439a

1-2 Initial Inspection

Inspect the shipping container for damage. If the shipping container is damaged, retain it until the contents of the shipment have been checked against the packing list checked for mechanical and electrical operation.

Calibration and Verification

The power meter comes fully calibrated from the factory and there are no user-serviceable parts inside. Anritsu recommends annual calibration and performance verification by local Anritsu service centers. If the contents should need to be returned, see “Preparation for Storage/Shipment” on page 1-4.

Connections

Sensor connections: Compatible sensors can be connected to any of the USB ports on the front or rear panel. However, the base ML2439A model only permits two sensors to be active at any one time. With the ML2439A-004 Option, four sensors can be active at any one time. Sensors become active when plugged into a USB port or immediately if already plugged in when the ML2439A powers up.

Triggered connections: Most triggered applications can use the RF signal applied to the sensors for triggering. For measurements requiring external triggering, connect the external trigger signal to the Trig In BNC connector on the rear panel and connect a Sync cable from the Sync connector on the meter to the Multi I/O port on the sensor.

Note	The Sync cable must be connected to the Sync port corresponding to the USB port for the sensor channel in use.

Remote connections: Connect the instrument to the BUS using the rear panel GPIB connector and cable. For Ethernet control, connect to the rear panel LAN connector. In most cases, it will be necessary to configure the interface using the System > I/O Config.

1-3 Instrument Care and Preventive Maintenance

Instrument care and preventive maintenance consist occasional cleaning of the instrument, inspecting and cleaning the RF connectors and all accessories before use.

Caution	Do not operate or store the power measurement equipment in extreme environments. Refer to the instrument Technical Data Sheet for the specified operating and storage conditions,

Connector Care

Clean the instrument with a soft, lint-free cloth dampened with water or water with a mild cleaning solution. Clean the RF connectors and center pins with a cotton swab dampened with denatured alcohol. Visually inspect the connectors. The fingers of the female connectors and the pins of the male connectors should be unbroken and uniform in appearance. If you are unsure whether the connectors are undamaged, gauge the connectors to confirm that the dimensions are correct.

Visually inspect the test port cables. The test port cable should be uniform in appearance and not stretched, kinked, dented, or broken.

Visually inspect connectors for general wear, cleanliness, and for damage such as bent pins or connector rings. Repair or replace damaged connectors immediately. Dirty connectors can limit the accuracy of your measurements. Damaged connectors can harm the instrument. Connection of cables carrying an electrostatic potential, excess power, or excess voltage can damage the connector, the instrument, or both.

To prevent damage to your instrument, do not use pliers or wrenches to tighten connectors. Inadequate torque settings can affect measurement accuracy. Over-tightening connectors can cause damage to the connector or instrument, Refer to the connector type torque settings listed in Table 1-1 on page 1-3.

Mechanical Shock

Handle power measurement devices with care. Avoid dropping, tossing, or any form of mechanical shock that will compromise the power measurement accuracy.

ESD Caution

The power sensors, like other high performance instruments, are susceptible to electrostatic discharge (ESD) damage. Coaxial cables and antennas often build up a static charge, which (if allowed to discharge by connecting directly to the instrument without discharging the static charge) may damage the PowerXpert input circuitry. Instrument operators must be aware of the potential for ESD damage and take all necessary precautions.

Operators should exercise practices outlined within industry standards such as JEDEC-625 (EIA-625), MIL-HDBK-263, and MIL-STD-1686, which pertain to ESD and ESDS devices, equipment, and practices. Because these apply to the PowerXpert, it is recommended that any static charges that may be present be dissipated before connecting coaxial cables or antennas to the instrument. This may be as simple as temporarily attaching a short or load device to the cable or antenna prior to attaching to the PowerXpert. It is important to remember that the operator may also carry a static charge that can cause damage. Following the practices outlined in the above standards will ensure a safe environment for both personnel and equipment.

Connecting

Connect RF connectors as follows:

1. Carefully align the connectors. The male connector center pin must slip concentrically into the contact fingers of the female connector.
2. Align and push connectors straight together. Do not twist or screw them together. A slight resistance can usually be felt as the center conductors mate.
3. To tighten, turn the connector nut, not the connector body. Damage can occur to the center conductor and to the outer conductor if the connector body is twisted.
4. If you use a torque wrench, initially tighten by hand so that approximately 1/8 turn or 45 degrees of rotation remains for the final tightening with the torque wrench.
5. Relieve any side pressure on the connection (such as from long or heavy cables) in order to assure consistent torque.
6. Use an open-end wrench to keep the connector body from turning while tightening with the torque wrench.

Disconnecting

Disconnect RF connectors as follows:

1. Use an open-end wrench to keep the connector body from turning while loosening with a second wrench.
2. Complete the disconnection by hand, turning only the connector nut.
3. Pull the connectors straight apart without twisting or bending.

Torque Settings

The recommended torque settings for the USB power sensor is listed in Table 1-1.

Table 1-1. Connector Wrench Requirements – Torque Wrenches and Settings – Open End Wrenches

Connector Type	Torque Wrench Size	Torque Specification	Open End Wrench
N	19 mm (3/4 in)	12 lbf·in (1.35 N·m)	Twist-on connector version, therefore no torque setting. Align connectors, thread, and then twist on until finger tight. Do not use a wrench or pliers to tighten.
K (2.92 mm)	8 mm (5/16 in)	8 lbf·in (0.90 N·m)	5/16 in. or 8 mm
V (1.85 mm)	8 mm (5/16 in)	8 lbf·in (0.90 N·m)	5/16 in. or 8 mm
W1 (1 mm)	6 mm	0.45 N·m (4 lbf·in)	6 mm x 7 mm
0.8 (0.8 mm)	6 mm	0.45 N·m (4 lbf·in)	6 mm x 7 mm

1-4 Preparation for Storage/Shipment

Preparing the power meter for storage consists of cleaning the unit, packing the inside with moisture-absorbing desiccant crystals, and storing the unit in the recommended temperature environment. Please refer to the data sheet for storage temperature recommendations.

To provide maximum protection against damage in transit, the power meter should be repackaged in the original shipping container. If this container is no longer available and the unit is being returned to Anritsu for repair, please advise Anritsu Customer Service; they will send a new shipping container free of charge. In the event neither of these two options is possible, instructions for packaging and shipment are given below:

Note	Disconnect any USB sensor cables before packaging the power meter.

- **Use a Suitable Container:** Obtain a corrugated cardboard carton. This carton should have inside dimensions of no less than 15 cm larger than the unit dimensions to allow for cushioning.
- **Protect the Instrument:** Surround the unit with polyethylene sheeting to protect the finish.
- **Cushion the Instrument:** Cushion the instrument on all sides by tightly packing urethane foam between the carton and the unit. Provide at least three inches of dunnage on all sides.
- **Seal the Container:** Seal the carton by using either shipping tape or an industrial stapler.

1-5 Calibration and Verification

The Power Meter comes fully calibrated from the factory and there are no field-adjustable components. Anritsu recommends annual calibration and performance verification by local Anritsu service centers.

Identification Number

The ML2439A identification number is affixed to the rear panel. Please use the complete ID number when corresponding with the Anritsu Customer Service department.

1-6 Contacting Anritsu for Sales and Service

To contact Anritsu, visit the following URL and select the services in your region:

https://www.anritsu.com/Contact-US/

Chapter 2 — Overview

2-1 Introduction

This chapter provides an overview of the ML2439A user interface.

Front Panel

The front panel of ML2439A is shown in Figure 2-1.

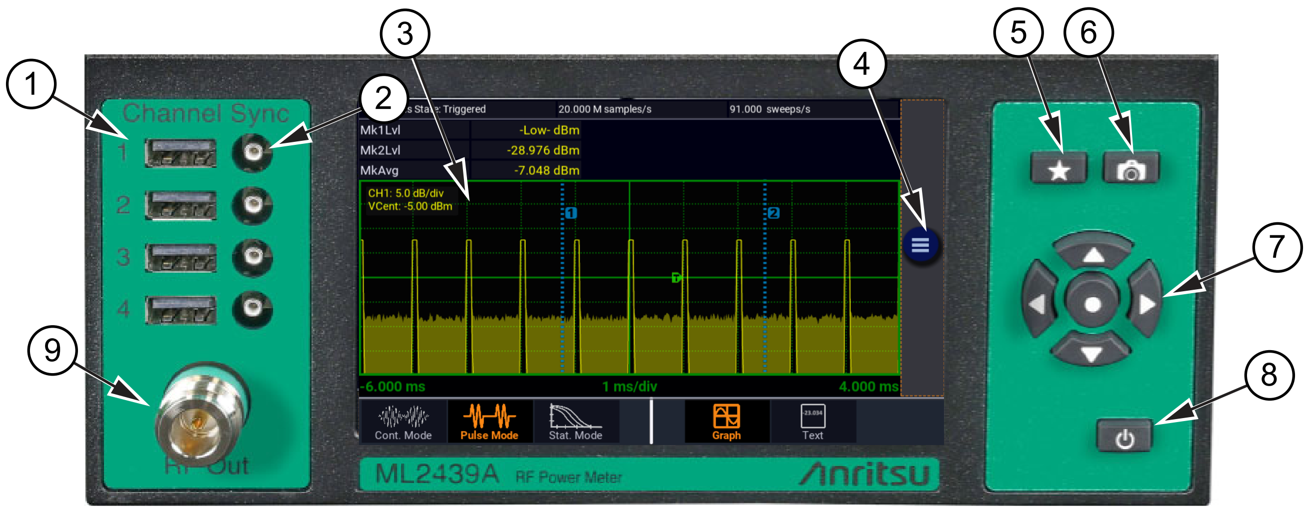


Figure 2-1. Front Panel

1. USB Power Sensor Input Ports: Four standard USB 2.0 Type A sensor inputs are located on the front and rear panels. Use these ports to insert USB power sensors or external memory device.
2. Trigger Input Ports (Only for MA244xxA sensors): Four standard SMB sensor trigger inputs are located on the front and rear panels.
3. Display Screen: 5-inch WVGA multi-touch display screen.
4. 3-Line Icon: Shows the Main menu when pressed. Refer to Section 3-3 “Main Menu” on page 3-8 for more information.
5. Favorites Key: Favorites key enables the user to setup a customized menu to provide grouping frequently used menu items into one convenient menu.
6. Camera: Saves the screenshot of the display screen. The internally stored images can be copied to an external USB storage device. Refer to the “Copying Screenshots to External Memory Device” on page 2-5 on how to retrieve the stored screenshots.
7. Keypad: Use the ◄ ► to move right or left on the display and in the menus. Use ▲ ▼ for incrementing or decrementing numeric parameters, or scrolling through multi-line or multi-page displays. Use the center keypad to select an on-screen item or menu and complete a numeric or pick-list entry.
8. On/Standby Button: Toggles the instrument between “on” and “standby”. Entering standby mode will perform a save of the internal circuits modes and will perform a save of the current instrument state before shutdown. Pressing and holding the On/Standby key for several seconds will force standby mode if the instrument has become non-responsive. In this case, no context save is performed.
9. RF Out: The output of the built-in 50 MHz programmable test source is available from a Type-N connector located on the front, or optionally on the rear panel of the instrument. This test source is used to verify basic performance of sensors used with the ML2439A.

Figure 2-1. Front Panel

Rear Panel

The rear panel of ML2439A is shown in Figure 2-2.

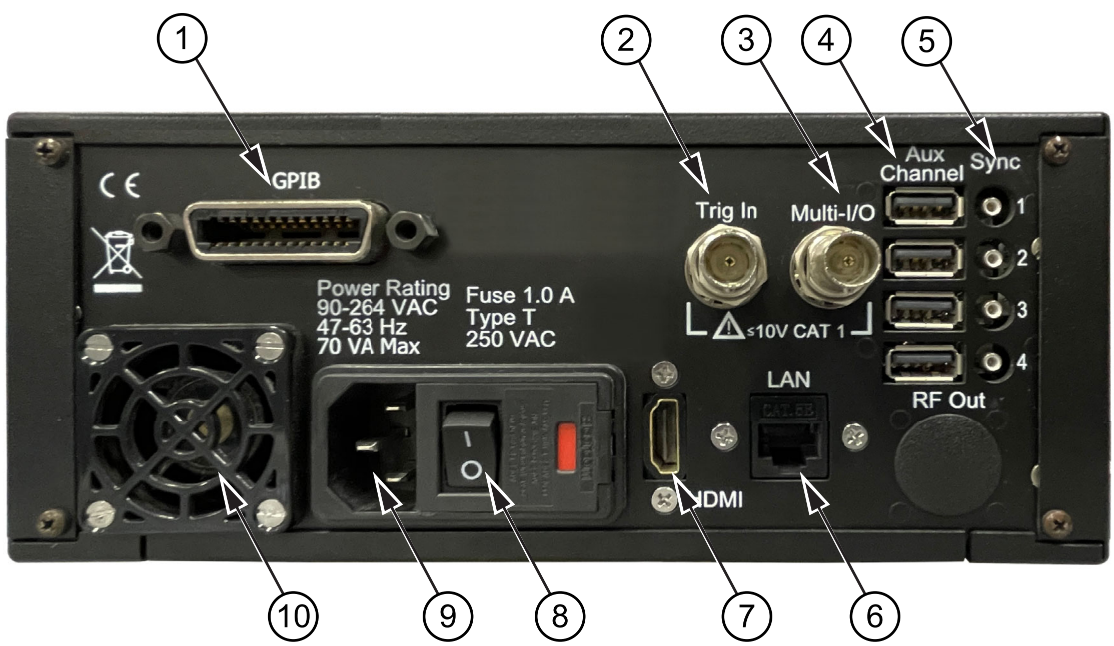


Figure 2-2. Rear Panel

1. GPIB: 24-pin GPIB (IEEE-488) connector for connecting the power meter to the remote control General Purpose Instrument Bus. GPIB parameters can be configured through the menu.
2. BNC Trigger Input: BNC input for connecting an external trigger signal to the power meter. Voltage range is ±5 volts, but the input impedance is 1 Megohm to allow use of common 10x oscilloscope probe for a ±50 volt input range.
3. BNC Multi I/O: Input/Output port.
4. USB Sensor Inputs: Four sensor inputs are located on the front and rear panels of the instrument. These are standard USB 2.0 Type A receptacles designed to accept only Anritsu power sensors or standard USB keyboards, mice, and flash drives.
5. Trigger Inputs: Four sensor trigger inputs are located on the front and rear panels of the instrument. These are standard SMB receptacles designed to accept only Anritsu power sensor trigger cables.
6. LAN: Connector for remote control and firmware updates. Allows DHCP or fixed (IP / Subnet) setting mode. LAN parameters can be configured through the menu.
7. HDMI: Receptacle for connecting an external monitor to mirror front panel display. The image resolution will be 800 x 480 and will be stretched to fit the external full display size.
8. On/Off Switch: The power switch is used to shut off main instrument power.
9. AC Mains Input: The module accepts a standard AC line cord, included with the power meter. The safety fuse may also be accessed once the line cord is removed. The instrument’s power supply accepts 90 to 264 VAC, so no line voltage selection switch is necessary.
10. Cooling Fan: The cooling fan ventilates the internal heat from the instrument. Keep the fan inlet and exhaust ports clear of obstructions at all times for proper ventilation and cooling of the instrument.

Figure 2-2. Rear Panel

Powering On ML2439A

To power on the ML2439A:

1. On the rear panel of the instrument connect the power supply cable to a suitable AC power outlet; 90 to 264 VAC, 47 to 63 Hz. The power supply will automatically adjust to voltages within this range.
2. Turn on the power switch.
3. Press the ON/STBY button on the front panel to turn the instrument on. The cooling fan and display backlight will turn on.

A bootup screen appears that shows the boot status. After a self-check, the instrument will execute the application program. There will be some temporary dialogs indicating application initialization and channel updating. After several seconds, a screen similar to Figure 2-3 on page 2-4 is displayed.

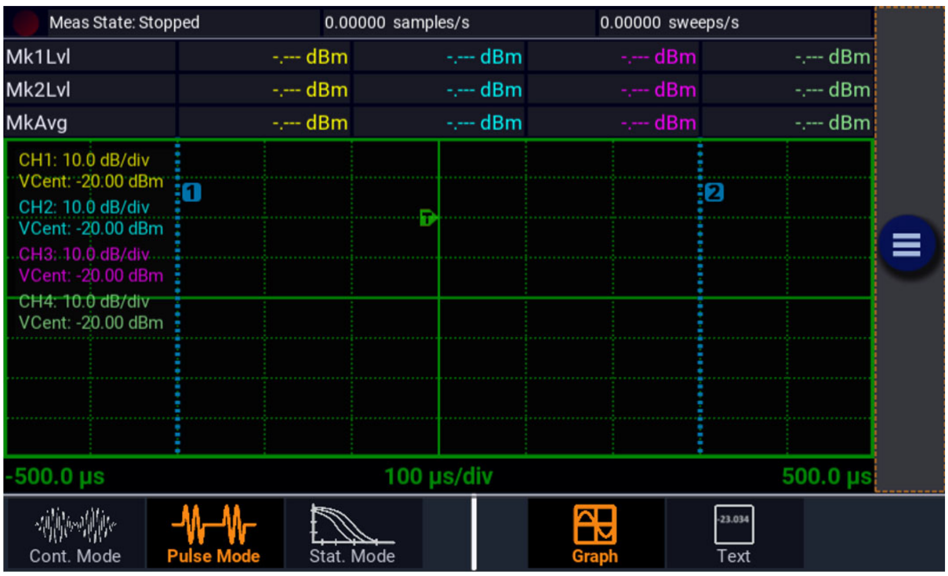


Figure 2-3. Typical Power-On Display

Note	The base ML2439A model operates two sensors at a time. With the ML2439A-004 Option, four sensors can be active at any given time.

On the front panel, press the center keypad key to bring up the on-screen menu. From the Main menu, use the touch screen or the ◄, ►, ▲, ▼, and Set keys to navigate to System > Reports > Configuration and press Show. The About screen is displayed as shown in Figure 2-4.

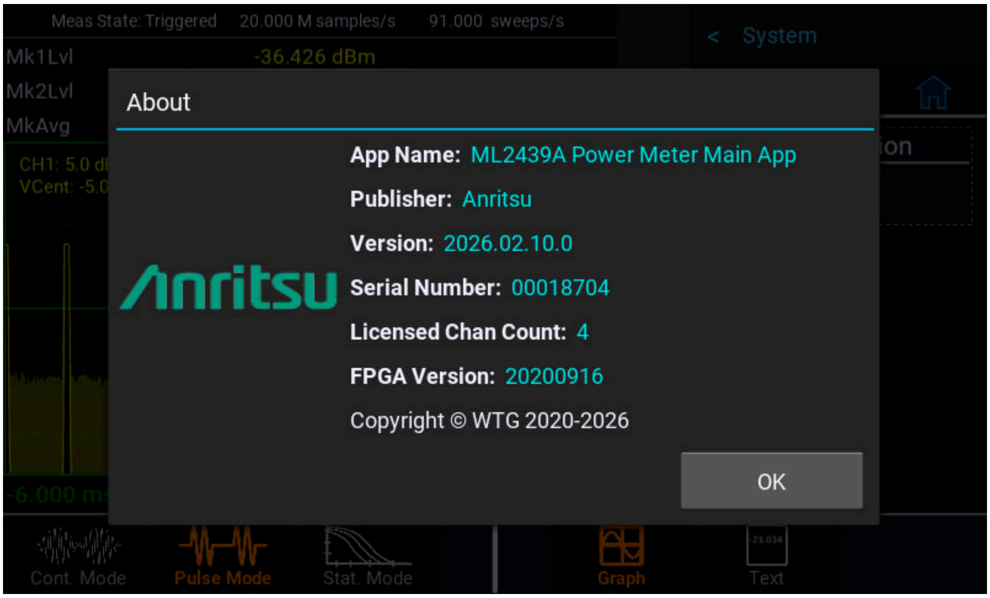


Figure 2-4. About Screen

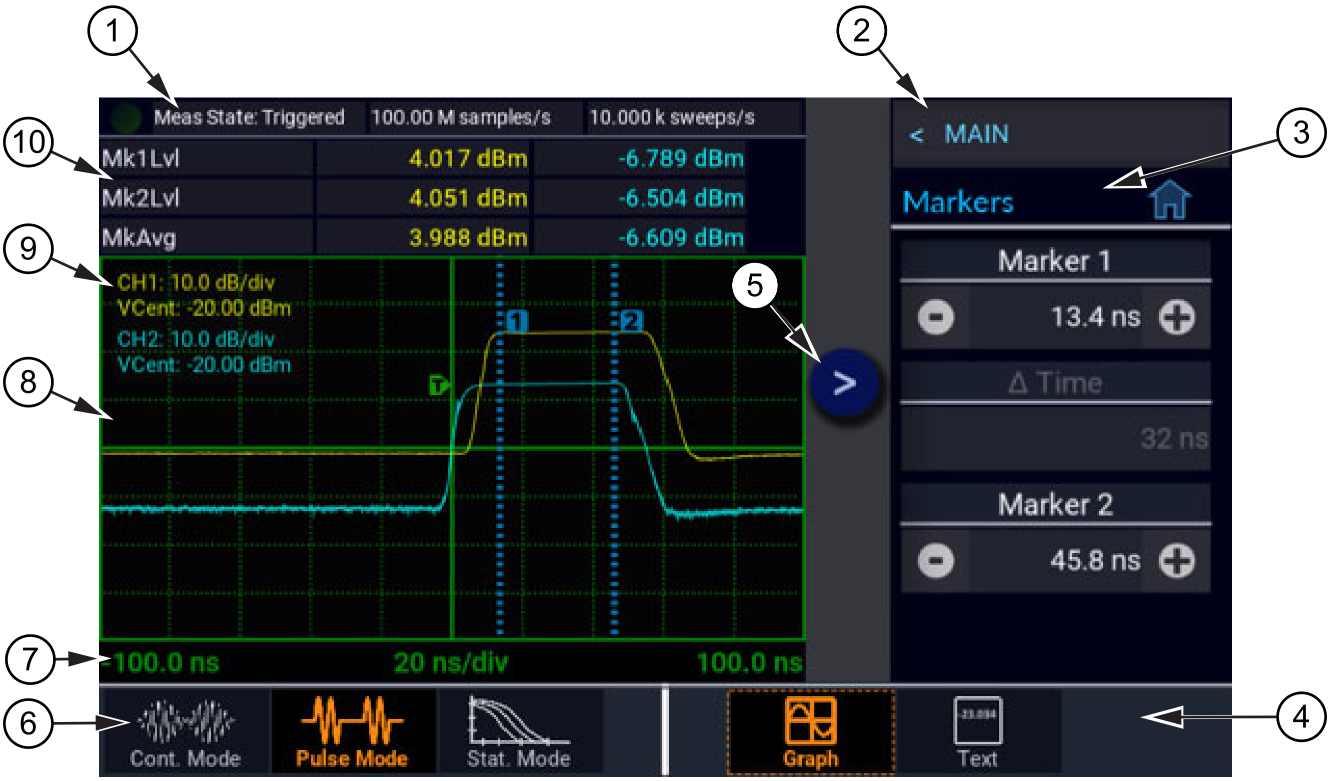
Copying Screenshots to External Memory Device

The internally saved screenshot images can be copied to USB memory device by following the steps below:

1. Go to Main > System > Exit > Exit To Desktop > Go.
2. Press File Manager and navigate to pi > wtg > pmx> pmx_img folder to retrieve the screenshots.

2-2 Touch Screen Display

The ML2439A Power Meter is controlled from the front panel touch screen and panel buttons. Figure 2-5 shows ML2439A user interface with the instrument using the Marker mode. The Text Display mode of the instrument provides a table view of measured parameters. Parameters depend on the Measure mode selected.



1. Status bar: Indicates the measurement acquisition status of the unit. In Pulse mode, the sample rate and number of sweeps per second are also shown. In Statistical mode, it indicates the gating setting in use, run time, and number of points.
2. Menu Path: Use to navigate the menu structure. Shows the menu that will be displayed when selected.
3. Current Menu/Home: Displays the name of the current menu and provides a home shortcut to the top-level Main menu. When in the Main or top-level menu, this field is not available.
4. Display Mode: Modes available are Graph and Text. The Graph Display mode for Continuous Measure mode will be a flat trace. Use Text Display mode for continuous signal measurements.
5. Menu Bar: Press the touch screen 3-Bar button to show the UI menu and > to hide the UI menus.
6. Measure Mode: Measurement modes are Continuous, Pulse, and Statistical.
7. Horizontal Scale: For Pulse and Continuous mode, indicates the time per division for the waveform display. In Statistical mode, the horizontal scale for the CCDF graph is in dBr (dB relative).
8. Main Display: Displays a plot when Graph display mode is selected. Displays a table of parameters when Text Display mode is selected.
9. Channel Status: Indicates which channels are ON and their individual scale and vertical center.
10. Parameters: Displays a table of measurements for each channel that is enabled on the meter. In Pulse and Continuous mode, measurements indicated are for power levels at each marker and the average power between the markers. For Statistical mode, the measurements are Average power, Maximum power, and Peak-to-Average Ratio or Crest Factor.

Figure 2-5. Touch Screen

Chapter 3 — Making Measurements

3-1 Introduction

The ML2439A power meter provides accurate power measurements using:

“Continuous Mode”

“Pulse Mode” on page 3-2

“Statistical Mode” on page 3-3

“Complementary Cumulative Distribution Function” on page 3-4

Continuous Mode

Use continuous mode for measuring repetitive signals. Since this mode performs a continuous measurement, it does not differentiate between the times a pulsed or periodic signal is off, and the times it is on. If you wish to make measurements that are synchronous with a period of a waveform, consider using Pulse mode instead.

Continuous mode is the best for the following types of measurement:

- Moderate signal level (above -40 dBm for Peak sensors and -60 dBm for RMS and CW sensors).
- Signal that is CW or continuously modulated with a modulation bandwidth that is less than the VBW of the sensor in use.
- Signal modulation may be periodic, but only non-synchronous measurements are needed (overall average and peak power).
- Noise-like digitally modulated signals such as CDMA and OFDM when only average measurements are needed.

The measured result is the average/RMS power of the signal. Measurements in Continuous mode are best viewed using the Text or Graph display view.

Figure 3-1 shows a two-channel measurement displaying an average, minimum, and maximum power in Continuous mode. Both Graph and Text mode are shown in the figure below.

Figure 3-1. Continuous Mode

Pulse Mode

The ML2439A provides a triggered Pulse mode for periodic or pulsed signals, analyze the power for a portion of the waveform, or a certain region of a pulse or pulse burst.

Trigger: The trigger signal can be an internal, triggered from a rising or falling edge on the measured signal, or external triggered from a rear-panel BNC input. The trigger level and polarity are both programmable, as is the trigger delay time and trigger holdoff time. Displays of both pre-trigger and post-trigger data are available, and an auto-trigger mode can be used to keep the trace running when no trigger edges are detected. Set an auto peak-to-peak trigger level setting to automatically set the trigger level based on the currently applied signal. The timebase can be set from 5 ns/div to 50 ms/div. The ML2439A graphical display has ten horizontal and eight vertical divisions. Vertical units can be set in dBm, Watts, and dB Volts. Setting vertical resolution does not affect the sensitivity of the instrument and is provided for ease of viewing.

Markers: Programmable markers can be moved to any portion of the trace that is visible on the screen, and these can be used to mark regions of interest for detailed power analysis. The ML2439A can display power at each marker, as well as average, minimum, and maximum power in the region between the two markers. The power during a Time Division Multiple Access (TDMA) or Global System Mobile (GSM) burst when only the modulated portion in the center region of a timeslot is of interest. By adjusting trigger delay and other parameters, measure the power of specific timeslots within the burst. Trigger holdoff provides burst synchronization even if there is more than one edge in the burst that may satisfy the trigger level. Set the holdoff time to slightly shorter than the bursts repetition interval to guarantee that triggering occurs at the same point in the burst each sweep. Figure 3-2 shows marker measurements for pulses on CH1 and CH2.

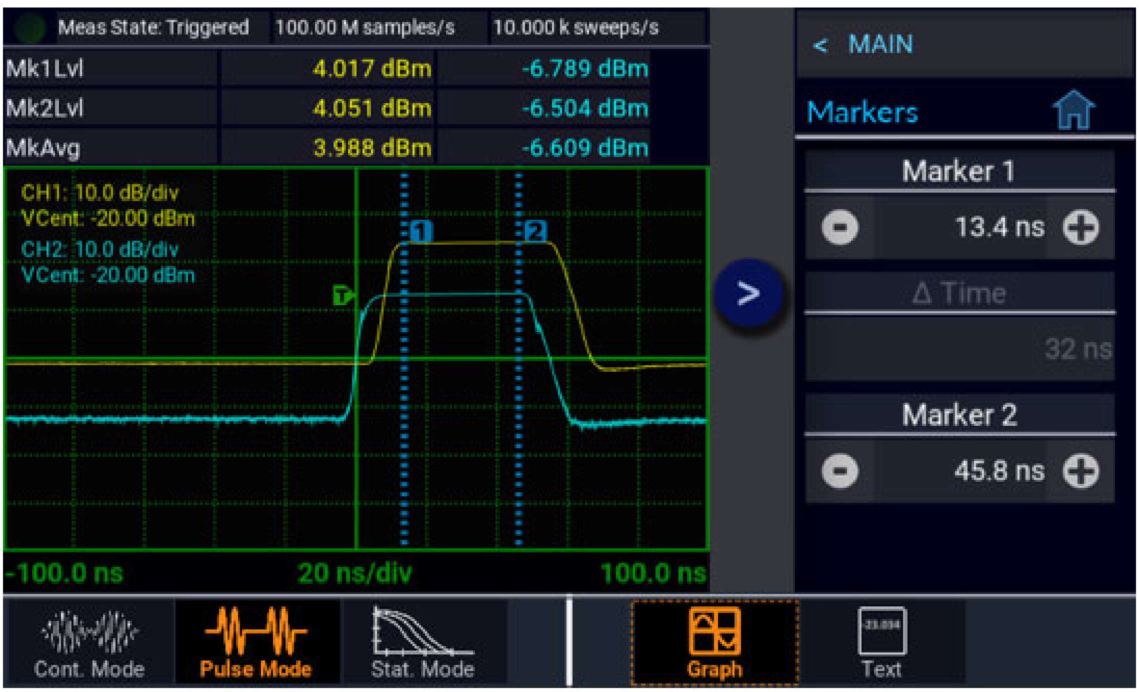


Figure 3-2. Marker Measurements

Pulse Mode Operation: Pulse mode requires a repeating signal edge that can be used as a trigger, or an external trigger pulse that is synchronized with the modulation cycle. Pulse mode performs measurements that are synchronous with the trigger (the measurements are timed or gated) so that the same portion of the waveform is measured on each successive modulation cycle. Multiple modulation cycles may be averaged together, and measurement intervals may span both before and after the trigger. Pulse mode is best for the following types of measurements:

- Moderate signal level (above about -40 dBm except when modulation is off).
- The signal is periodic.
- A time snapshot of a single event is needed (minimum single-shot time is 200 nanoseconds).
- Typical modulation and signal types: LTE, 5G, RADAR, SatCom, TCAS, Bluetooth™, Wireless LAN.

Statistical Mode

Statistical mode is available when using peak power sensors with the ML2439A. It is the best for analyzing signals with a high crest factor, that are noise-like with random or infrequent peaks, or are modulated in a random, non-periodic fashion. Statistical mode provides information about the *probability of occurrence* of various power levels without regard for *when* those power levels occurred. In the Statistical mode the instrument continuously samples the input signal and processes all of the samples to build power histograms. Many digitally modulated spread-spectrum formats use bandwidth coding techniques or many individual modulated carriers to distribute a source's digital information over a wide bandwidth, and temporally spread the data for improved robustness against interference. When these techniques are used, it is difficult to predict when peak signal levels will occur. Analysis of millions of data points gathered during a sustained measurement of several seconds or more can yield the statistical probabilities of each signal level with a high degree of confidence. Statistical mode is best for the following types of measurements:

- Moderate signal level (above about -40 dBm except when modulation is off).
- Noise-like digitally modulated signals such as CDMA (and all its extensions) or OFDM when probability information is helpful in analyzing the signal.
- Any signal with random, infrequent peaks, when you need to know the peak-to-average ratio or Crest Factor and just how infrequent those peaks are.

Complementary Cumulative Distribution Function

The statistical analysis of the current sample population is displayed using a normalized Complementary Cumulative Distribution Function (CCDF) presentation shown in Figure 3-3. The CCDF is the probability of occurrence of a range of peak-to-average power ratios on a log-log scale. CCDF is non-increasing in y-axis and the maximum power sample lies at 0%. A cursor provides measurement of power or percentage at a user-defined point on the CCDF. As with all other graphical displays, the trace can be easily scaled and zoomed, or the statistical data may be presented as a table in Text Display mode.

Figure 3-3. CCDF Plot

The CCDF has become a useful tool for analyzing communication signals that have a Gaussian-like distribution (CDMA, OFDM) where signal compression can be observed at rarely occurring peaks. It is most often presented graphically using a log-log format where the x-axis represents the relative offset in dB from the average power level and the log-scaled y-axis is the percent probability that power will exceed the x-axis value.

In a non-statistical peak power measurement, the peak-to-average ratio is the parameter that describes the headroom required in linear amplifiers to prevent clipping or compressing the modulated carrier. The meaning of this ratio is easy to visualize in the case of simple modulation in which there is close correspondence between the modulating waveform and the carrier envelope. When this correspondence is not present, the peak-to-average ratio alone does not provide adequate information. It is necessary to know what fraction of time the power is above (or below) particular levels. For example, some digital modulation schemes produce narrow and relatively infrequent power peaks that can be compressed with minimal effect. The peak-to-average ratio alone would not reveal anything about the fractional time occurrence of the peaks, but the CCDF clearly shows this information. In Figure 3-4, assume a full length run of one hour plus has been made and the CCDF is analyzed. At 0% is the maximum peak power that occurred during the entire run. At 1% is the power level that was exceeded only 1% of the time during the entire run.

Figure 3-4. CCDF Analyzed

Note that this analysis does not depend upon any particular test signal, or upon synchronization with the modulating signal. In fact, the analysis can be done using actual communication system signals. Normal operation is not disturbed by the need to inject special test signals. This type of analysis is particularly suited to the situation in which the bit error rate (BER) or some other error rate measure is correlated with the percentage of time that the signal is corrupted. If known short intervals of clipping are tolerable, the CCDF can be used to determine optimum transmitter power output. The CCDF is also used to evaluate various modulation schemes to determine the demands that will be made on linear amplifiers and transmitters and the sensitivity to non-linear behavior.

3-2 Manual Operation

In the manual mode, the instrument is controlled from the front panel by selecting items from a system of displayed menus. To properly input commands and data using these menus, you should be familiar with the menu conventions described in the next section.

Control Menus

The menus that control the ML2439A Power Meter are accessed from the top-level MAIN menu. Display the MAIN menu by selecting the icon on the display. The MAIN menu structure for Pulse mode operations is illustrated in Figure 3-5.

Menus and parameters may be selected by using the front panel ◄, ►, ▲, ▼ keys to browse and using the l key to select the entry or by use of the touch screen.

The ML2439A base model only permits two sensors to be active at any one time. With the ML2439A-0004 Option, four sensors can be active at any one time. In the Menu Reference that follows the designation "Channel" is used to mean that all active channels have menus of this structure type except for different colorization.

Some menus have mode-dependent properties. Typically, one or more menu boxes in a submenu may change as the measurement mode is changed from Continuous to Pulse to Statistical. In the Menu Reference that follows these menus are indicated for mode dependency.

Menus with more selections than what fits on the display can be scrolled with the touch screen or front panel buttons.

Figure 3-5. Pulse Menu

Numerical Data Entry

Numerical data can be incremented/decremented by selecting the "+" and "–" icons with the front panel keys or by touching them. Selecting the numeric setting brings up an on-screen numeric keypad similar to the one shown in Figure 3-6.

Figure 3-6. Data Entry Keypad

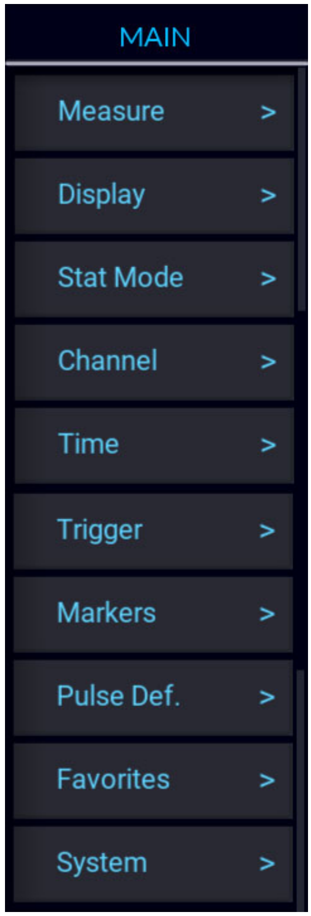
Parameter Terminator List

Some parameters use a menu or pick-list of settings to choose from. The Trigger source setting seen in Figure 3-7 is an example of a pick-list. Use the front panel arrow up and down icons to cycle through the settings or select the value to display the pick-list.

Figure 3-7. Terminator List

3-3 Main Menu

The ML2439A Main Menu is shown in Figure 3-8. Each menu function is described below.



Measure: See "Measure Menu" on page 3-9.

Display: See "Display Menu" on page 3-9.

Stat Mode: See "Stat Mode Menu" on page 3-10. Only available if the statistical mode in the front display is selected. Refer to "Typical Power-On Display" on page 2-4.

Channel: See "Channel Menu" on page 3-11.

Time: See "Time Menu" on page 3-14.

Trigger: See "Trigger Menu" on page 3-15.

Markers: See "Markers Menu" on page 3-16.

Pulse Def. See "Pulse Def. Menu" on page 3-16.

Favorites: This function is not implemented at this time.

System: See "System Menu" on page 3-18.

Figure 3-8. Main Menu

Measure Menu

The Measure menu is described in Figure 3-9.

Measurement: The state of the data acquisition mode for taking measurements. If Measurement is set to Run, the ML2439A immediately begins taking measurements (Continuous and Statistical modes), or arms its trigger and takes a measurement each time a trigger occurs (Pulse Mode). If set to Stop, the measurement will begin (or be armed) if Start is selected under the Single Sweep setting (Pulse Mode Only), and will stop once the measurement criteria (averaging) has been satisfied.

Meas. Clear: Selecting Execute clears display traces, data buffers, and clears averaging filters to empty. In Statistical Measure mode, the menu item is replaced with Stat Capture and selecting Reset clears the acquired sample population.

Single Sweep: Only available in Pulse mode. Select to start a single measurement cycle in Pulse mode when Measurement is set to Stop. Enough trace sweeps must be triggered to satisfy the channel averaging setting.

Meas. Settings: This will load the default operating parameters listed in Table 3-3 into the meter. Only the settings shown in the table are affected and all others remain in their current state.

Figure 3-9. Measure Menu

Display Menu

The Display menu is described in Figure 3-10.

View: Selecting Text displays a table of measurements for the current measurement mode. In Continuous mode, selecting Text displays the enabled channel power as shown in Figure 3-1 on page 3-1. Selecting Graph displays the trace graphical view.

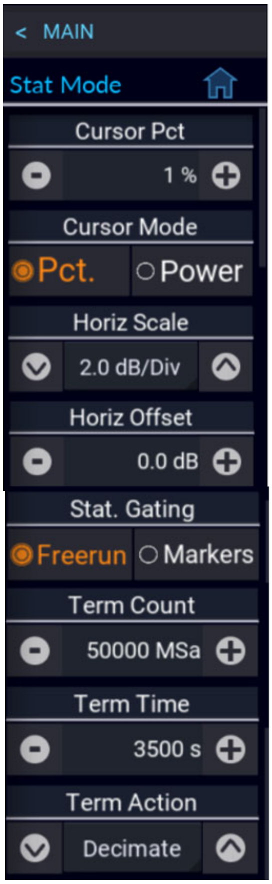
Envelope: Enables or disables the Envelope display mode. In Pulse and Modulated modes, the Envelope display is used to highlight the range of signal excursions. When Envelope display mode is On, the trace is drawn as a wide line, which is filled in between the minimum and maximum power readings. A series of vertical pixels, representing the range of signal excursions or "envelope" of the signal will be illuminated for each horizontal trace pixel. Envelope display is only available for Peak Power sensors.

Key Beep: Enables and disables the audible key beep.

Figure 3-10. Display Menu

Stat Mode Menu

The Statistical Mode menu is described in Figure 3-11. Note that this menu is only available when Stat. Mode is selected.



Cursor Pct: Sets the CCDF cursor to the desired probability. When Cursor mode is set to Power, the menu item changes to Cur Pow Ref and sets the desired power.

Cursor Mode: Select the independent variable for the CCDF cursor. If Percent is selected, relative power at the cursor's intersection with the CCDF curve will be measured. If Power is selected, probability at the cursor's intersection with the CCDF curve will be measured.

Horiz Scale: Select the horizontal scale for the statistical graphic display.

Horiz Offset: Select the horizontal offset for statistical graphic display.

Stat. Gating: Selects Freerun or Marker gating for statistical acquisition. If Freerun is selected, then all the samples are acquired without regard to sweep acquisition. If Markers are selected, then only samples within the time marker interval on the Pulse mode triggered sweep will be included in the statistical sample population.

Term Count: Sets the terminal sample count for the CCDF acquisition.

Term Time: Sets the terminal running time for the CCDF acquisition.

Term Action: Select the action to take when either the terminal count is reached or terminal time has elapsed. Selecting Decimate will divide all sample bins by 2 and continue. The total sample count will be halved each time a decimation occurs. Selecting Restart clears the statistical sample population and starts a new one. Selecting Stop will stop accumulating samples and hold the result.

- Decimate: Divide all sample bins by 2 and continue.

Figure 3-11. Statistical Mode Menu

Channel Menu

The Channel menu is described in Figure 3-12.

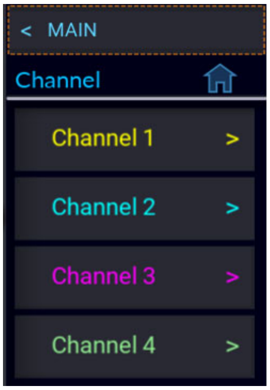
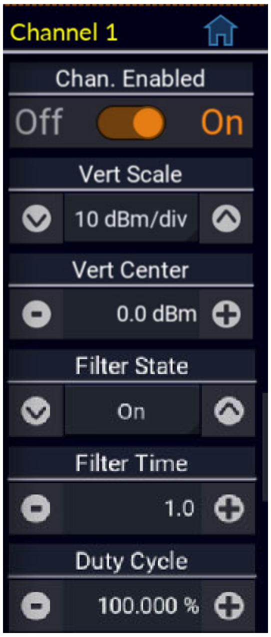
	**Channel 1 - 4:** Opens the Channel menu for the selected channel. Each Channel function provides the same menu and is described below.

Figure 3-12. Channel Menu

Channel 1 Submenu

An individual Channel 1 submenu is described in Figure 3-13.



Chan. Enabled: Toggles display of the trace and measurements for the channel. The channel may still be used as a trigger source when set to Off.

Vert Scale: Set the power or voltage vertical axis level for the trace display based on the units as shown below.

dBm: 0.1, 0.2, 0.5 1, 2, 5, 10, 20, 50 dB/div

Watts: 1pW to 500 MW/div in a 1-2-5 progression

Volts: 1µV to 100 kV/ div in a 1-2-5 progression

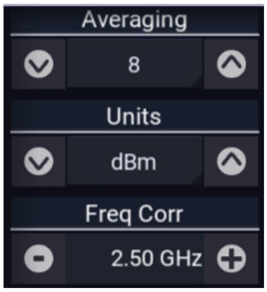
Vert Center: Set the power or voltage level of the horizontal centerline of the graph for the specified channel in the selected channel units.

Filter State: Available in Continuous mode only. Set the current value of the integration filter on the selected channel. The filter can be set to Off, On, or Auto. Off, provides no filtering, and can be used at high signal levels when absolute minimum settling time is required. On, provides a user-specified integration time to be entered for use. Auto, uses a variable amount of filtering, which is set automatically by the power meter based on the current signal level to a value that gives a good compromise between measurement noise and settling time at most levels.

Filter Time: Available in Continuous mode only. Sets the length of the integration filter. The filter is a “sliding window” which averages samples taken within a time window whose duration is set by this field. All samples within the time window are equally weighted.

Duty Cycle: Available in Continuous mode only. Sets the duty cycle in percent for calculated CW pulse power measurements. Setting the duty cycle to 100% is equivalent to a CW measurement.

Figure 3-13. Channel 1 Submenu



Averaging: UnitsScale

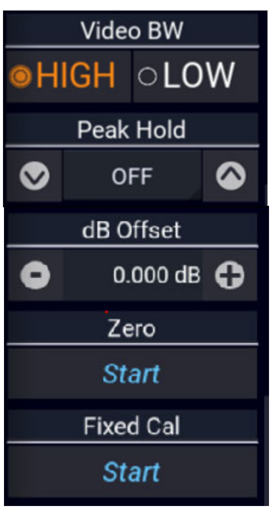
Only available in Pulse and Statistical modes. Set the number of traces averaged together to form the measurement result on the selected channel. Averaging can be used to reduce display noise on both the visible trace, and on marker and automatic pulse measurements. Trace averaging is a continuous process in which the measurement points from each sweep are weighted (multiplied) by an appropriate factor and averaged into the existing trace data points. In this way, the most recent data will always have the greatest effect on the trace waveform, and older measurements will be decayed at a rate determined by the averaging setting and trigger rate. This averaging technique is often referred to as “exponential” averaging because averaging imposes a first-order Infinite Impulse Response (IIR) exponential filter with a time constant of "n" where n is the Average (number of averages) setting.

Note: For timebase settings of 200 ns/div and faster, the MA244xxA Series power sensors acquire samples using a technique called equivalent time or random interleaved sampling (RIS). In this mode, not every pixel on the trace gets updated on each sweep, and the total number of sweeps needed to satisfy the average setting will be increased by the sample interleave ratio of that particular timebase. At all times the average trace is the average of all samples for each pixel, and the min/max are the lowest and highest of that same block of samples for each pixel.

Units: Select the channel units. The trace may be shown in units of dBm, Watts, or Volts. The Units selection determines the range of the scale values and also affects displayed text and measurement values.

Freq. Corr: Sets measurement frequency for the RF signal that is applied to the sensor for the current measurement. The appropriate frequency calibration factor from the sensor’s calibration table will be interpolated and applied automatically. Application of this calibration factor compensates for the effect of variations in the flatness of the sensor’s frequency response.

Note: The power sensor has no way to determine the carrier frequency of the applied signal, so the user must always enter the frequency.



Video BW: Sets the sensor video bandwidth for the channel. HIGH is appropriate for most measurements, and the actual bandwidth depends upon the sensor model. LOW bandwidth offers additional noise reduction for CW or signals with very low modulation bandwidth. If LOW bandwidth is used on signals with fast modulation, measurement errors may result if the sensor cannot track the fast-changing envelope of the signal.

dB Offset: Sets a measurement offset in dB for the selected channel. This is used to compensate for external couplers, attenuators, or amplifiers in the RF signal path ahead of the power sensor.

Zero: Performs a zero offset null adjustment. The sensor does not need to be connected to any calibrator for zeroing. This action removes the effect of small, residual power offsets, and should be performed prior to low-level measurements. The procedure is often performed in-system. There should be no RF signal applied to the sensor input prior to zeroing.

Fixed Cal: Performs a single point sensor gain calibration of the selected channel at 0 dBm and the current frequency setting. This requires a calibrated 0 dBm (1.00 mW) signal source at the current measurement frequency. This procedure calibrates the sensor’s gain at a single point. At other levels, that gain setting is combined with stored linearity factors to compute the actual power.

Figure 3-13. Channel 1 Submenu

Time Menu

The Time menu is described in Figure 3-14.

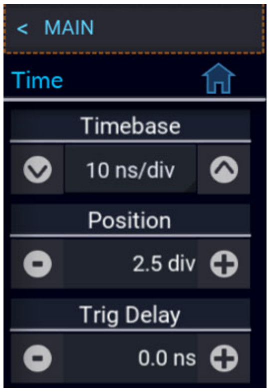
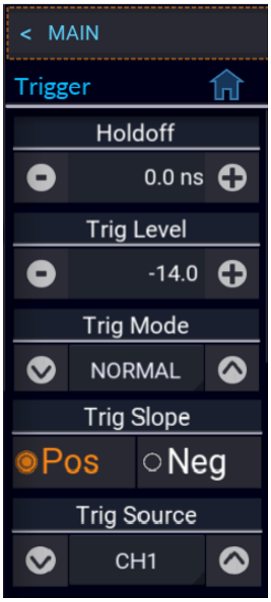
	**Timebase:** Controls the timebase or horizontal scale of the acquisition and is noted on the horizontal axis label of the Trace View. The Timebase pulldown menu permits selection of fixed timebase ranges from 5 ns/div to 50 ms/div (sensor series dependent) in a 1-2-5 progression. **Position:** Sets the location of the trigger point on the acquired trace waveform. The Trig Delay setting is in addition to this setting, and will cause the trigger position to appear in a different location. **Trig Delay:** The trigger delay time is set in seconds with respect to the trigger. Positive values mean that the trace display shows a time interval after the trigger event. This positions the trigger event to the left of the trigger point on the display, and is useful for viewing events during a pulse, or some fixed delay time after the rising edge trigger. Negative trigger delay mean that the trace display shows a time interval before the trigger event, and is useful for looking at events preceding the trigger edge.

Figure 3-14. Time Menu

Trigger Menu

The Trigger menu function is described in Figure 3-15.



Trigger Holdoff: Set the trigger holdoff time. Trigger holdoff is used to disable the trigger for a specified amount of time after each trigger event. The holdoff time starts immediately after each valid trigger edge and will not permit any new triggers until the time has expired. When the holdoff time is up, the trigger re-arms, and the next valid trigger event (edge) will cause a new sweep. This feature is used to help synchronize the power meter with burst waveforms such as a TDMA or GSM frame. The trigger holdoff resolution is 0.01 microseconds, and it should be set to a time that is longer than the burst duration but shorter than the frame repetition interval

Trigger Level: Sets the threshold level for the trigger signal used in the Auto and Normal trigger modes. The trigger level can be entered numerically or changed by using arrow keys. The trigger level range has a range that is sensor model dependent
(see the sensor specifications for your specific sensor model).

The trigger range is automatically adjusted to include the dB Offset parameter set for the source channel. For example, if the trigger level = 10 dBm and the dB Offset is changed from 0 to 20 dB, then the offset-adjusted trigger level will be displayed to the user as 30 dBm. Likewise, the maximum trigger level range will be extended to 40 dBm. The trigger level set point and setting range are both shifted upward by 20 dB.

Trigger Mode: Set the trigger mode for synchronizing data acquisition with pulsed signals. Normal mode will cause a sweep to be triggered each time the power level crosses the preset trigger level in the direction specified by the trigger slope setting. If there are no edges that cross this level, no data acquisition will occur. Auto mode operates in much the same way as Normal mode but will automatically generate a trace if no trigger edges are detected for a period of time (100 to 500 milliseconds, depending upon timebase). This will keep the trace updating even if the pulse edges stop. The Auto PK-PK mode operates the same as Auto mode but will adjust the trigger level to halfway between the highest and lowest power or voltage levels detected. This aids in maintaining synchronization with a pulse signal of varying level. The Freerun mode forces unsynchronized traces at a high rate to assist in locating the signal.

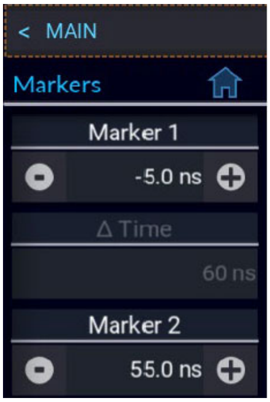
Trigger Source: Set the trigger source used for synchronizing data acquisition. The CH # settings use the signal from the associated sensor. Ext setting uses the signal applied to the rear panel TRIG IN connector.
The trigger source can be any of the resource channels (CH1, CH2, etc.), or the Ext (external) trigger input signal. The IND (independent) trigger setting provides each connected sensor to trigger independently from its own RF input.
The external trigger is attached to the Trig In BNC connector on the rear of the ML2439A Power Meter and requires a TTL signal level, minimum pulse width of 10 ns, and maximum frequency of 50 MHz.

Trigger Slope: Set the trigger slope or polarity. When set to +, trigger events will be generated when a signal's rising edge crosses the trigger level threshold. When – is selected, trigger events are generated on the falling edge of the pulse.

Figure 3-15. Trigger Menu

Markers Menu

The Markers menu is described in Figure 3-16.



Marker #: Set the time position of marker 1 or 2 relative to the trigger. Note that time markers must be positioned within the time limits of the trace window in the graph display. If a time outside of the display limits is entered, the marker will be placed at the first or last time position as appropriate.

Time: Displays the result of Marker 2 - 1 in seconds. This item is read only.

Figure 3-16. Markers Menu

Pulse Def. Menu

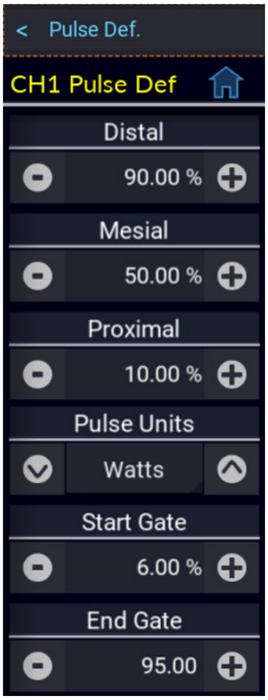
The Pulse Definition menu is described in Figure 3-17.

Pulse Def. Opens the Pulse Definition menu for the selected channel. Each of the Channels 1 through 4 provide the same functions and are described below.

Figure 3-17. Pulse Definition Menu

CH1 Pulse Def Submenu

The Channel 1 Pulse Definition (CH1 Pulse Def) submenu is described in Figure 3-18.



Distal: Sets the pulse amplitude percentage that defines the end of a rising edge or beginning of a falling edge transition. Typically, this is 90% voltage or 81% power relative to the top level of the pulse. This setting is used when making automatic pulse rise-time and fall-time calculations.

Mesial: Sets the pulse amplitude percentage that defines the midpoint of a rising or falling edge transition. Typically, this is 50% voltage or 25% power relative to the top level of the pulse. This setting is used when making automatic pulse width and duty cycle calculations.

Proximal: Sets the pulse amplitude percentage that defines the beginning of a rising edge or end of a falling edge transition. Typically, this is 10% voltage or 1% power relative to the top level of the pulse. This setting is used when making automatic pulse rise-time and fall-time calculations.

Pulse Units: Controls whether the distal, mesial, and proximal thresholds are computed as voltage or power percentages of the top/bottom amplitudes. If Volts is selected, the pulse transition thresholds are computed as voltage percentages, and if Watts, they are computed as power percentages.
Many pulse measurements call for 10% to 90% voltage (which equates to 1% to 81% power) for rise-time and fall-time measurements, and measure pulse widths from the half-power (–3 dB, 50% power, or 71% voltage) points. The Pulse Units setting is independent of the channel's display units setting.

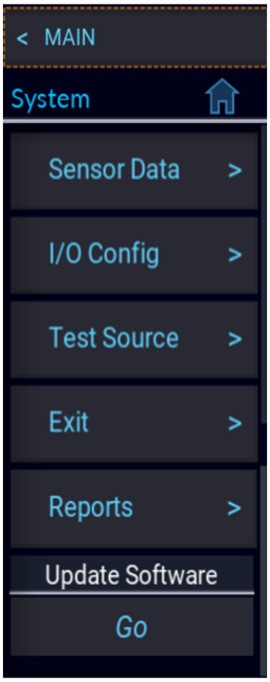
Start Gate: Sets the beginning of the pulse measurement region as a percentage of the pulse width. The Start Gate has a continuous range of 0.0% to 40.0% of the pulse width and may be entered numerically or varied using the up or down arrows.

End Gate: Sets the end of the pulse measurement region as a percentage of the pulse width. The End Gate has a continuous range of 60.0% to 100.0% of the pulse width and may be entered numerically or varied using the up or down arrows. The Gate settings define the measurement interval for the following power related pulse measurements: Pulse Average, Pulse Peak, Pulse Minimum, and Pulse Droop/Tilt. Pulse timing measurements between mesial crossings such as width and period are not affected. The purpose of the Pulse Gate setting is to exclude edge transition effects from the pulse power measurements.

Figure 3-18. Channel 1 Pulse Definition Submenu

System Menu

The System menu is described in Figure 3-19.



System: The System menu displays the available system-level features. Each menu is described below.

Sensor Data: See "Sensor Data" on page 3-18.

I/O Config: See "I/O Config" on page 3-19.

Test Source: See "Test Source" on page 3-19.

Exit: See "Exit" on page 3-20

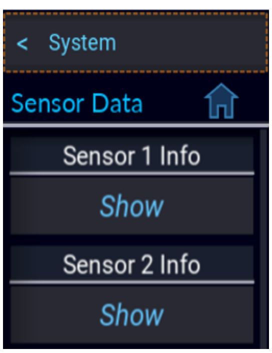
Reports: See "Reports" on page 3-20.

Update Software: See "Update Software" on page 3-20.

Figure 3-19. System Menu

Sensor Data

The Sensor Data submenu is described in Figure 3-20



Sensor Data: Provides information about the selected sensor in a pop-up dialog as shown below.

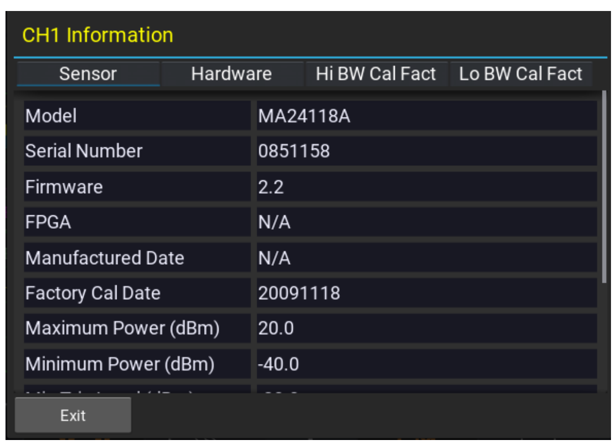
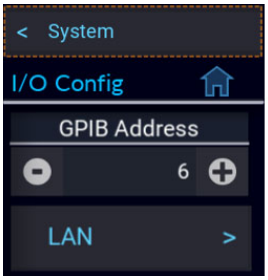
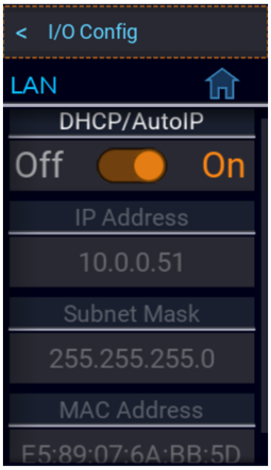


Figure 3-20. Sensor Data Menu

I/O Config

The I/O Config submenu is described in Figure 3-21





GPIB Adress: Set the GPIB address in use for instruments equipped with GPIB option.

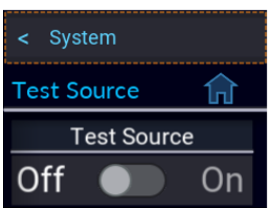
LAN: Set up LAN configuration.

- **DHCP/AutoIP**: If DHCP/AutoIP is enabled (On), the instrument will attempt to obtain its IP Address and Subnet Mask, a DHCP (dynamic host configuration protocol) server on the network. If no DHCP server is found, the instrument will select its own IP Sets the end of the pulse measurement region as a percentage of the pulse width. The End Gate has a continuous range of 60.0% to 100.0% of the pulse width and may be entered numerically or varied using the up or down arrows. The Gate settings define the measurement interval for the following power related pulse measurements: Pulse Average, Pulse Peak, Pulse Minimum, and Pulse Droop/Tilt. Pulse timing measurements between mesial crossings such as width and period are not affected. The purpose of the Pulse Gate setting is to exclude edge transition effects from the pulse power measurements. If DHCP/AutoIP is disabled (Off), the instrument will use the IP Address and Subnet Mask values that have been set by the user.
- **IP Address**: Set the Internet Protocol (IP) address of the Ethernet adapter. If DHCP/AutoIP mode is enabled, this menu is read-only.
- **Subnet Mask**: Set the subnet mask for the Ethernet adapter. If DHCP/AutoIP mode is enabled, this menu is read-only.
- **MAC Address**: Displays the mask for the Ethernet adapter. If DHCP/AutoIP mode is enabled, this menu is read-only MAC address for the Ethernet adapter. This menu item is read-only.

Figure 3-21. I/O Config Menu

Test Source

The Test Source submenu is described in Figure 3-22

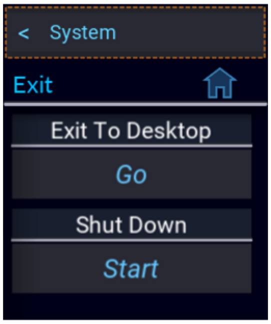


Test Source: Enable or Disable output of the built-in 0 dBm 50 MHz test source.

Figure 3-22. Test Source Submenu

Exit

The Exit submenu is described in Figure 3-23



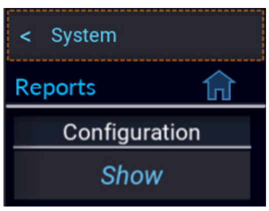
Exit: Select Go to exit the ML2439A Power Meter main application and view the OS desktop.

Shut Down: Shuts down power to the ML2439A putting the meter in standby mode and is the same as pressing the ON/Standby button on the front panel.

Figure 3-23. Exit Submenu

Reports

The Reports submenu is described in Figure 3-24

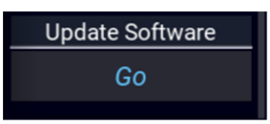


Reports: Select Show to display the About dialog with configuration information for the ML2439A Power Meter as shown in Figure 2-4 on page 2-5.

Figure 3-24. Reports Submenu

Update Software

The Reports submenu is described in Figure 3-25



Update Software: Select Go to search the connected USB drive for the *.tar software update file and update or re-install the version found.

Figure 3-25. Update Software Submenu

Chapter 4 — Pulse Measurement

4-1 Introduction

This chapter provides an overview of power/pulse measurement.

Unmodulated Carrier Power

The average power of an unmodulated carrier consisting of a continuous, constant amplitude sinewave signal is also termed continuous wave (CW) power. For a known value of load impedance R, and applied voltage Vrms, the average power is:

$P = Vrms^2/R$ (watts)

Power meters designed to measure CW power can use thermoelectric-based sensors which respond to the heating effect of the signal or diode detectors which respond to the voltage of the signal. With careful calibration accurate measurements can be obtained over a wide range of input power levels.

Modulated Carrier Power

The average power of a modulated carrier which has varying amplitude can be measured accurately by a CW type power meter with a thermoelectric detector, but the lack of sensitivity will limit the range. Diode detectors can be used at low power, square-law response levels. At higher power levels the diode responds in a more linear manner and significant error results.

Pulse Power

Pulse power refers to power measured during the on time of pulsed RF signals. Traditionally, these signals have been measured in two steps:

- thermoelectric sensors measure the average signal power,
- the reading is then divided by the duty cycle to obtain pulse power, P_{pulse}

P_{pulse} = Average Power/ Duty Cycle, where Duty Cycle = Pulse Width/Pulse Period

Peak Power

The Model ML2439A makes power measurements in a manner that overcomes the limitations of the pulse power method and provides both peak power and average power readings for all types of modulated carriers. The fast-responding diode sensors detect the RF signal to produce a wideband video signal, which is sampled with a narrow sampling gate. The video sample levels are accurately converted to power on an individual basis at up to a 100 MSa/sec rate. Since this power conversion is corrected based upon the sensor’s linearity correction table, these samples can be averaged to yield average power without restriction to the diode square-law region. In addition, if the signal is repetitive, the signal envelope can be reconstructed using an internal or external trigger. The envelope can be analyzed to obtain waveshape parameters including, pulse width, duty cycle, overshoot, rise time, fall time, and droop. In addition to time domain measurements and simple averaging, the Model ML2439A has additional capabilities that perform statistical analysis on a complete set of continuously sampled data points. Data can be viewed and characterized using a CCDF presentation format. These analysis tools provide invaluable information about peak power levels and their frequency of occurrence, and are especially useful for non-repetitive signals, such as those used in 5G and Wi-Fi applications.

Diode Detection

Wideband diode detectors are the dominant power sensing device used to measure pulsed RF signals. However, several diode characteristics must be compensated to make meaningful measurements. These include the detector's nonlinear amplitude response, temperature sensitivity, and frequency response characteristic. Additional potential error sources include detector mismatch, signal harmonics, and noise.

Detector Response

The response of a single-diode detector to a sinusoidal input is given by the diode equation:
$i = I_s(e^{\alpha v} - 1)$

where:

i = diode current

v = voltage across the diode

I_s = saturation current

α = constant

An ideal diode response curve is plotted in Figure 4-1

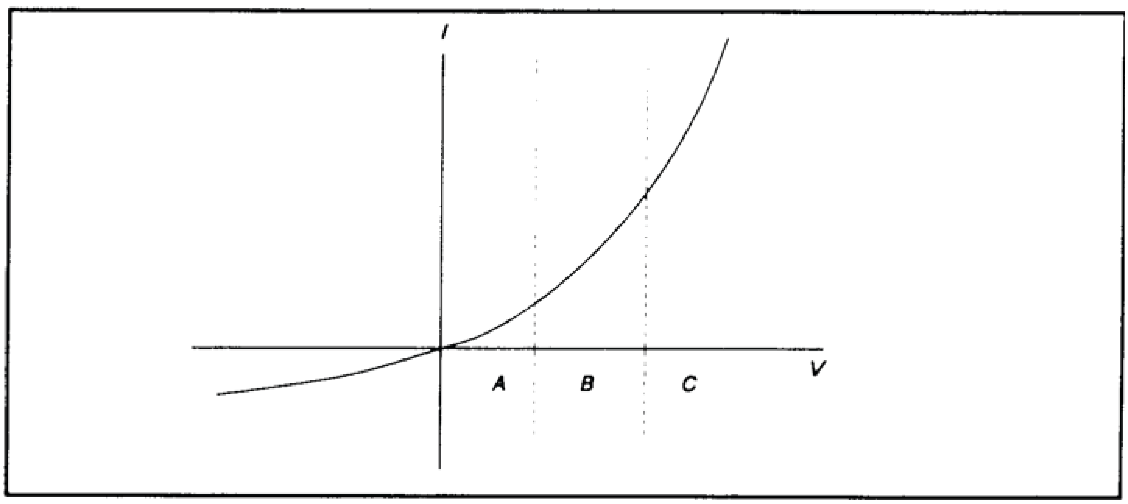


Figure 4-1. Ideal Diode Response

The curve indicates that for low microwave input levels (Region A), the single-diode detector output is proportional to the square of the input power. For high input signal levels (Region C), the output is linearly proportional to the input. In between these ranges (Region B), the detector response lies between square-law and linear.

For accurate power measurements over all three regions, the detector response is pre-calibrated over the entire range. The calibration data is stored in the instrument and recalled to adjust each sample of the pulse power measurement.

Temperature Effects

The sensitivity of microwave diode detectors (normally Low Barrier Schottky diodes) varies with temperature. However, ordinary circuit design procedures that compensate for temperature-induced errors adversely affect detector bandwidth. A more effective approach involves sensing the ambient temperature during calibration and recalibrating the sensor when the temperature drifts outside the calibrated range.

This process can be made automatic by collecting calibration data over a wide temperature range and saving the data in a form that can be used by the power meter to correct readings for ambient temperature changes.

Frequency Response

The carrier frequency response of a diode detector is determined mostly by the diode junction capacitance and the device lead inductances. Accordingly, the frequency response will vary from detector to detector and cannot be compensated readily. Power measurements must be corrected by constructing a frequency response calibration table for each detector.

Mismatch

Sensor impedance matching errors can contribute significantly to measurement uncertainty, depending on the mismatch between the device under test (DUT) and the sensor input. This error cannot be easily calibrated out, but can be minimized by employing an optimum matching circuit at the sensor input.

Signal Harmonics

Measurement errors resulting from harmonics of the carrier frequency are level-dependent and cannot be calibrated out. In the square-law region of the detector response, section A of Figure 4-1 on page 4-2, the signal and second harmonic combine on a root mean square basis. The effects of harmonics on measurement accuracy in this region are relatively insignificant. However, in the linear region, section C of Figure 4-1 on page 4-2, the detector responds to the vector sum of the signal and harmonics. Depending on the relative amplitude and phase relationships between the harmonics and the fundamental, measurement accuracy may be significantly degraded. Errors caused by even-order harmonics can be reduced by using balanced diode detectors for the power sensor. This design responds to the peak-to-peak amplitude of the signal, which remains constant for any phase relationship between fundamental and even-order harmonics. Unfortunately, for odd-order harmonics, the peak-to-peak signal amplitude is sensitive to phasing, and balanced detectors provide no harmonic error improvement.

Noise

For low-level signals, detector noise contributes to measurement uncertainty and cannot be calibrated out. Balanced detector sensors improve the signal-to-noise ratio by 3 dB, because the signal is twice as large.

4-2 Pulse Definitions

IEEE Standard Pulse Terms and Definitions "provides fundamental definitions for general use in time domain pulse technology." Several key terms defined in the standard are reproduced in this subsection, which also defines the terms appearing in the ML2439A text mode display of automatic measurement results.

Standard IEEE Pulse

The key terms defined by the IEEE standard are abstracted and summarized below. These terms are referenced to the standard pulse illustrated in Figure 4-2.

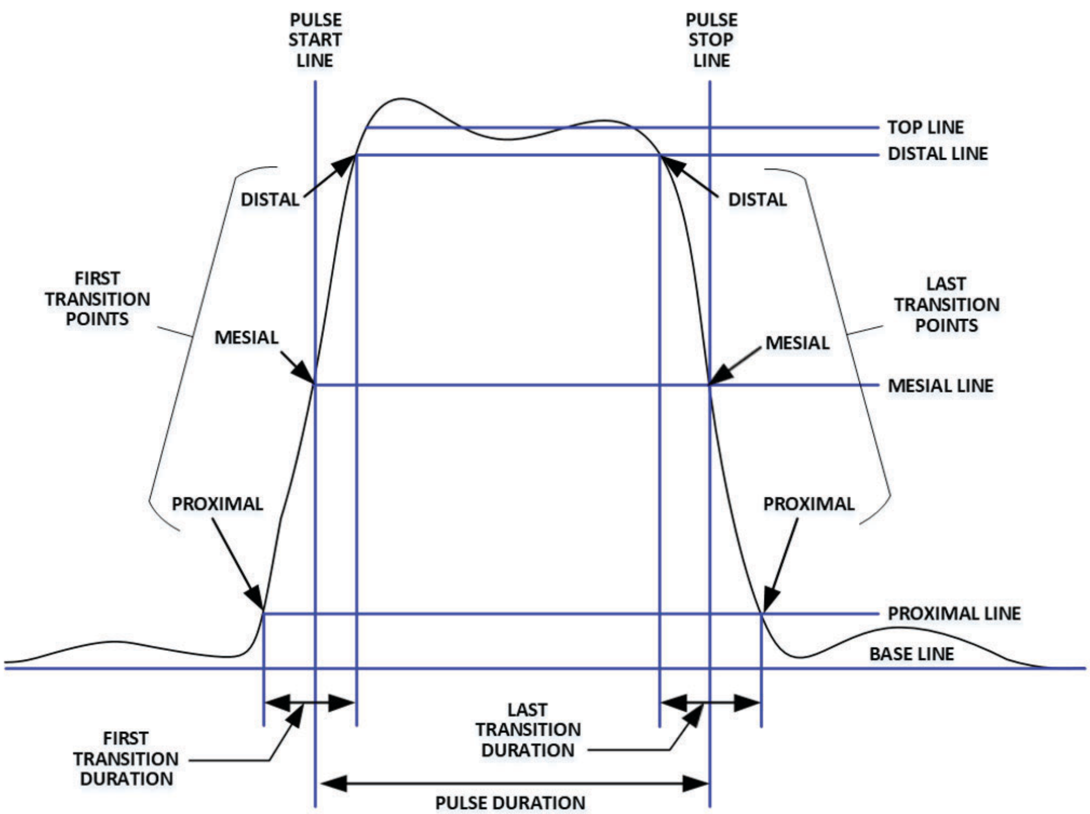


Figure 4-2. IEEE Standard Pulse

Pulse Definitions

Base Line: The two portions of a pulse waveform which represent the first nominal state from which a pulse departs and to which it ultimately returns.

Top Line: The portion of a pulse waveform which represents the second nominal state of a pulse.

First Transition: The major transition of a pulse waveform between the base line and the top line (commonly called the rising edge).

Last Transition: The major transition of a pulse waveform between the top of the pulse and the base line (commonly called the falling edge).

Proximal Line: A magnitude reference line located near the base of a pulse at a specified percentage (normally 10%) of pulse magnitude.

Distal Line: A magnitude reference line located near the top of a pulse at a specified percentage (normally 90%) of pulse magnitude.

Mesial Line: A magnitude reference line located in the middle of a pulse at a specified percentage (normally 50%) of pulse magnitude.

Chapter 5 — SCPI Commands

5-1 Introduction

This chapter contains information on all SCPI programming commands accepted and implemented by the ML2439A Power Meter. The majority of the GPIB commands have equivalents in the front panel menu settings. The ML2439A Power Meter supports the IEEE 488.2–1992 GPIB standard in ML2439A (native) mode (HP emulation commands are not GPIB 488.2 compliant). For further information about GPIB programming, refer to the IEEE 488.1/2 Standards documents.

5-2 Introduction to SCPI Programming

The Standard Commands for Programmable Instruments (SCPI) defines a set of standard programming commands for use by all SCPI compatible instruments. SCPI is intended to give the user a consistent environment for program development. It does so by defining controller messages, instrument responses, and message formats for all SCPI compatible instruments. The set of SCPI commands implemented by the ML2439A interfaces a comprehensive set of programming functions covering all the major functions of the ML2439A power meter.

Query Commands

Many ML2439A (native) GPIB commands have an equivalent query command that will return a current value or setting. Query commands and their returned strings are provided with each command where applicable. A complete listing of valid query commands and returned strings is provided in Table 5-1 on page 5-48.

LAN Configuration

The ML2439A LAN interface is configured using the System > I/O Config > LAN menu. The instrument may be set to automatically accept its IP address and associated information from a DHCP server, or the configuration data may be entered manually.

The ML2439A communicates via HiSLIP (High-Speed LAN Instrument Protocol), which is a TCP/IP based format that provides GPIB operation to be emulated via the LAN. Once the LAN parameters have been configured, the controller can use the instrument's IP address to assist the remote-control software in locating and connecting to the ML2439A. Typically, the host will use VISA to provide the interface layer between the instrument and the remote-control software.

GPIB Configuration

GPIB remote control is enabled with option ML2439A-GPIB.

The ML2439A-GPIB interface is ready for use. Assign a GPIB address using the System > I/O Config. The primary address can be set to any value from 1 to 30 inclusive. The value assigned must be unique to each GPIB device. Secondary address is not implemented.

5-3 SCPI Language

ML2439A instruments may be remotely controlled using commands that follow the industry standard SCPI programming conventions.

SCPI Structure

The SCPI instrument model defines a hierarchical command structure based on “command nodes”. Each node may contain commands or names of a next-level command node. Each command is formed of a series of keywords joined together and delimited by a colon “:” character. The command begins with a colon at the “root node”, and traverses downwards through the command tree to form a specific command. This structure is very similar to a DOS file system, where the file system begins at the root level (“:”), and each directory (SCPI subsystem) may contain a list of files (SCPI commands) and lower- level directories. To execute an individual command, the entire command name (“path”) must generally be specified, although there are several shortcuts available to reduce the command string length.

SCPI subsystems or command groups are usually aligned with instrument functions, and the standard provides a number of pre-defined subsystems that can be used for most instrument types. For example, the top-level SENSe subsystem groups commands that are related to sensing signals (detection, amplification, digitization, linearization), while the OUTPut subsystem contains commands that control output functions of the instrument such as voltage output or controlling an RF reference output.

5-4 ML2439A Native Commands

This section provides an alphabetical listing of the GPIB commands (mnemonics) used to program the Model ML2439A Power Meter in ML2439A (native) mode. The emulation mode can be set through the front panel SYSTEM > more > more > Rear panel > GPIB > MODE menu or through the GPIB command EMUL.

All ML2439A (native) GPIB commands that use parameters must have a space between the command header and the first parameter, and all subsequent parameters must be separated by a comma (,). Multiple commands may be sent on the same line, but must be separated by a semicolon (;).

The format for ML2439A (native) GPIB commands is:

<command header><space><parameter 1>,<parameter n>,...

The end of the command text must be terminated with a line feed character (0Ah, decimal 10) or a GPIB End of Transmission State (EOI), or both.

Long and Short Form Keywords

Each command or subsystem may be represented by either its full keyword, or a short form of that keyword. The short form is typically the first several characters of the full name, although this is not necessarily the case. The short form of each keyword is identified in this manual by the keyword characters shown in UPPERCASE, while the long form will be shown in mixed case. For example, the short form of "CALCulate" is "calc", while the long form is "calculate". Long form and short form commands may be used interchangeably, but only the exact forms are permitted – intermediate length commands will not be recognized. Sending "CALCUL" will cause an error.

Note that not all keywords have long forms – in this case, the entire keyword will be shown in uppercase.

While uppercase and lowercase text is used to identify keywords, SCPI is generally case-insensitive, so it is acceptable to send uppercase, lowercase, or mixed case keywords to the instrument. The only exception is when a command accepts a literal string argument. In this case, quotes may be used to delimit a string of user-defined case.

Subsystem Numeric Suffixes

Certain subsystems, such as the SENSe or CALCulate subsystems in the ML2439A, often exist as more than one instance (often called a "channel" in an instrument). In this case, an optional numeric suffix may be used to define the channel. If this suffix is not present, the default channel is assumed. For example, SENSe or SENSe1 defines operations affecting the instrument's "Channel 1" measurement path, while SENSe2 commands will apply to channel 2.

Colon Keyword Separators

The colon (":") character is used similar to the way a slash or backslash is used in a filesystem. Prefixing a command string with a colon is optional and is ignored by the ML2439A.

Command Arguments and Queries

Many commands require arguments. In this case, the entire command string is sent, followed by the argument. A space is used to separate the command from the argument. For example, "SENSe:CORRection:DCYCle 25.0" sets duty cycle correction to a value of 25.0. Arguments may be numeric, or alphanumeric. If a command requires more than one numeric argument, the arguments must be sent as a comma delimited list.

To read the current value of a particular parameter, the Query Form of its command may be used. A command query is formed by appending a question-mark ("?") suffix to the command instead of an argument list. There should not be any whitespace between the command and the suffix. For example, "SENSe:CORRection:DCYCle?" queries the duty cycle correction parameter, and causes the instrument to return its current value.

ML2439A SCPI Implementation

The SCPI implementation for the ML2439A provides a single or dual SENSe sub-system to handle sensor input and a matching single or dual CALCulate sub-system to process the data obtained from the sensors into useful results. A TRIGger sub-system provides for measurement and signal synchronization. DISPlay commands are used for graph and text display control, formatting and timebase selection. The CALibration sub-system is used to calibrate power sensors. Channel dependent commands end with a number to indicate the desired channel as follows:

Examples:

:CALCulate:STATe ON	Turn on measurement channel 1 (default channel number)
:CALCulate1:STATe ON	Turn on measurement channel 1 (specified channel number)
:CALC:STAT ON	Turn on measurement channel 1 (short form, default chan #)
:CALC1:STAT ON	Turn on measurement channel 1 (short form, specified chan #)
:CALCulate:STATe?	Query the state of measurement channel 1 (default chan #)
:CALC:STAT?	Query the state of channel 1 (short form, default chan #)
:CALCulate1:STATe?	Query the state of measurement channel 1 (specified chan #)
:CALC1:STAT?	Query the state of channel 1 (short form, specified chan #)
:DISPlay:PULSe:TIMEBASE 0.0001	Set timebase range to 100 us/Div (time in seconds)
:DISP:PULS:TIMEBASE 100 us	Set timebase range to 100 us/Div (short form with time units)
:SENSe:CORRection:OFFSet 0.42	Set channel 1 offset correction to 0.42 dB (chan units dBm)
:TRIGger:LEVel –3.12	Set trigger level to –3.12 dBm (trig units dBm)
:SENS:CORR:OFF 0.42; :TRIG:LEV –3.12	Concatenated commands using semi-colon (short form)

In the discussion and tables below, the following notation will be used:

Command name long and short form:	SYSTem
Optional command name in brackets:	SYSTem:ERRor[:NEXT]?
Command with channel dependence:	CALCulate[1|2]:STATe OFF Default channel 1: CALCulate:STATe OFF
Explicit channel 1:	CALCulate1:STATe OFF
Select channel 2:	CALCulate2:STATe OFF
Short Form:	CALC2:STAT OFF
Command which takes numeric argument:	SENSe1:AVERage <numeric_value> Same command; query: SENSe1:AVERage?
Command with literal text argument:	TRIGger:SOURce <character data> Command with no query form: *CLS
Command with query form only:	SENSe:SENSOR:TYPE?

Syntax Notes

Square brackets [ ] are used to enclose the list of valid channels for a command, or a list of command options separated by the vertical separator bar | character. This character is for syntax only, and is not to be entered as part of the command. By default, if no channel number is specified, Channel 1 is selected.

A literal argument denoted by <character data> indicates a word or series of characters, which must exactly match one of the choices for the command. An argument denoted by <numeric_value> requires a string which, when converted to a number, is within the range of valid arguments. Numerical values can generally be in any common form including decimal and scientific notation. <Boolean> indicates an argument which must be either true or false. Boolean arguments are represented by the values 0 or OFF for false, and 1 or ON for true. Queries of Boolean parameters always return 0 or 1.

Curly braces { } are used to enclose two or more possible choices for a mandatory entry, separated by the comma character. One of the enclosed options MUST be inserted into the command, and the braces are not to be entered as part of the command.

IEEE 488.2 Commands

The purpose of IEEE488.2 commands is to provide management and data communication instructions for the system by defining a set of "*" commands (an asterisk followed by a three-character code). These commands provide device control and monitoring.

*IDN?

Description:	Return the instrument identification string. This string contains the manufacturer, model number, serial number and firmware version number.
Syntax:	*IDN?
Returns:	< Mfgr, Model#, Serial#, Version# >
Valid Modes:	Any

*OPC

Description:	Clears the OPC (Operation Complete) status flag. This command is issued before the command to be checked for completion. After this, the flag may be queried by *OPC? until a value of one is returned, indicating the command has completed. Note that the query is not a true query - a value of zero will never be returned.
Syntax:	*OPC
Argument:	None
Valid Modes:	Any

*OPC?

Description:	This command examines the OPC (Operation Complete) status flag and returns a ”1” if all pending operations are complete. If pending operations are not yet complete, it does not return.
Syntax:	*OPC?
Returns:	Always returns 1 to indicate operations complete. Otherwise, does not return.
Valid Modes:	Any

*TST?

Description:	Self-test query. This command initiates a self-test of the instrument and returns a result code when complete. The result is zero for no errors, or a signed, 16-bit number if any errors are detected.
Syntax:	*TST
Returns:	Error Code
Valid Modes:	Any

*WAI

Description:	Wait command. This command insures sequential, non-overlapped execution. The ML2439A always operates in non-overlapped, sequential mode, therefore this command is accepted as valid, but takes no action.
Syntax:	*WAI
Argument:	None
Valid Modes:	Any

5-5 CALCulate Subsystem

Functions in the CALCulate subsystem are used to configure the measurement mode and control which portions of the acquired measurement data is used and how it is processed to yield a finished measurement. In addition to measurement mode, CALCulate is used to define mathematical operations, and measurement units. The numeric suffix of the CALCulate program mnemonic in the CALCulate commands refers to a processing and display "channel", that is CALCulate1 and CALCulate2 represent the power meter's Channel 1 and Channel 2 functions. The CALCulate commands generally DO NOT affect the data acquisition portion of the measurement. In a signal-flow block diagram, the CALCulate block operations will follow those of the SENSe block. Note that CALCulate commands will not generate an error if used with a disconnected or non-existing channel on the ML2439A.

CALCulate:DCYCle

Description	Set or return the duty cycle correction factor currently in use on the selected channel.
Syntax:	CALCulate[1|2|3|4]:CORRection:DCYCle <numeric value>
Argument:	<numeric_value> = 0.01 to 100.00 percent Valid Modes: CW Sensor (Modulated Mode)
Modes:	Any

CALCulate:MODE

Description	Set or return the system measurement mode. MODULATED mode is a continuous measurement mode primarily for continuously modulated or CW signals. PULSE mode is a signal triggered, oscilloscope-like mode that acquires and analyzes a pulsed signal as a series of one or more triggered sweeps. STATISTICAL mode performs long-term power distribution analysis on modulated signals, and may be operated in a start-stop continuous mode, or a decimated continuous mode. Note that the measurement mode is global and affects all channels. If any channel has a CW sensor installed, peak or statistical measurements will be unavailable, but the "primary "average power measurement will still be performed.
Syntax:	CALCulate:MODE <character data>
Argument:	<character data> = {MODulated, PULSe, STATistical}
Modes:	Any

CALCulate:PKHLD

Description:	Set or return the operating mode of the selected channel's peak hold function. When set to OFF, instantaneous peaks are only held for a short time, and then decayed towards the average power at a rate proportional to the filter time. This is the best setting for most signals, because the peak will always represent the peak power of the current signal, and the resulting peak-to-average ratio will be correct shortly after any signal level changes. When set to ON, instantaneous peaks are held until reset by a new INITiate command or cleared manually. This setting is used when it is desirable to hold the highest peak over a long measurement interval without any decay.
Syntax:	CALCulate[1|2|3|4]:PKHLD <Boolean>
Argument:	<Boolean> = { 0, 1, OFF, AVG, INST } Valid Modes: Modulated and Pulse Modes

CALCulate:STATe

Description:	Set or return the measurement state of the selected channel. When ON, the channel performs measurements; when OFF, the channel is disabled and no measurements are performed.
Syntax:	CALCulate[1|2|3|4]:STATe <Boolean> Argument: <Boolean> = { 0, 1, OFF, ON }
Valid Modes:	Any

CALCulate:UNITs

Description:	Set or return units for the selected channel. For power sensors, voltage is calculated with reference to the sensor input impedance. Note that for ratiometric results, logarithmic units will always return dBr (dB relative) while linear units return percent.
Syntax:	CALCulate[1|2|3|4]:UNITs <character data>
Argument:	<character data> = {DBMw, Watts, Volts, DBV, DBMV, DBUV}
Valid Modes:	Any

5-6 DISPlay Subsystem

The DISPlay group of commands is used to control the selection and presentation of textual, graphical and TRACe measurements.

DISPlay:CLEar

Description:	Clear display traces and all data buffers. Clears averaging filters to empty. Does NOT clear errors.
Syntax:	DISPlay:CLEar
Argument:	None Valid Modes: All

DISPlay:ENVELOPE[:STATe]

Description:	Enable or disable the Envelope mode. Syntax: DISPlay:ENVELOPE <Boolean> Argument: <Boolean> = { 0, 1, ON, OFF }
Valid Modes:	Pulse and Modulated

DISPlay:MODUlated:TIMEBASE

Description:	Set or return the Modulated Mode timebase in seconds/division. The ML2439A has fixed timebase settings in a 1-2-5 sequence. If the argument does not match one of these settings, it will be forced to the next highest entry.
Optional units:	minutes.
Syntax:	DISPlay:MODUlated:TIMEBASE <numeric_value>
Argument:	<numeric_value> = 10e-9 to 10 s, (1-2-5 sequence), 30 s, 1, 2, 5, 10, 30, 60 min
Valid Modes:	Modulated Mode Note: There are separate time bases for the modulated mode and the pulse mode. The arguments selected are saved and restored independently by mode.

DISPlay:MODUlated:TSPAN

Description:	Set or return the horizontal time span of the display in modulated mode. Time span = 10* Time/Division.
Optional units:	minutes.
Syntax:	DISPlay:MODUlated:TSPAN <numeric_value>
Argument:	<numeric_value> = 100e-9 to 100 s in a 1-2-5 sequence, 300 s, 10, 20, 50, 100, 300, 600 min
Valid Modes:	Modulated mode

DISPlay:PULSe:TIMEBASE

Description:	Set or return the Pulse Mode timebase in seconds/division. The ML2439A has fixed timebase settings in a 1-2-5 sequence. If the argument does not match one of these settings, it will be forced to the next highest entry.
Optional units:	minutes.
Syntax:	DISPlay:PULSe:TIMEBASE <numeric_value>
Argument:	<numeric_value> = 5e-9 to 50e-3, (1-2-5 sequence) 60 min Valid Modes: Pulse Mode Note: There are separate time bases for the modulated mode and the pulse mode. The arguments selected are saved and restored independently by mode.

DISPlay:PULSe:TSPAN

Description:	Set or return the horizontal time span of the display in pulse mode. Time span = 10* Time/Division.
Optional units:	minutes.
Syntax:	DISPlay:PULSe:TSPAN <numeric_value>
Argument:	<numeric_value>= 50e-9 to 500e-3 in a 1-2-5 sequence, 600 min
Valid Modes:	Pulse mode Note There are separate time bases for the modulated mode and the pulse mode. The arguments selected are saved and restored independently by mode.

DISPlay:[TEXt:]LIN:RESolution

Description:	Set or return the display resolution for linear power and voltage readings. The number of significant digits displayed is equal to the argument. This command also sets the resolution of measurements returned in remote mode.
Syntax:	DISPlay:[TEXt:]LIN:RESolution <numeric_value>
Argument:	<numeric_value> = 3 to 5
Valid Modes:	All

DISPlay:[TEXt:]LOG:RESolution

Description:	Set or return the display resolution for logarithmic power and voltage readings. The number of decimal places displayed is equal to the argument. This command also sets the resolution of measurements returned in remote mode.
Syntax:	DISPlay:[TEXt:]LOG:RESolution <numeric_value>
Argument:	<numeric_value> = 0 to 3
Valid Modes:	All

DISPlay:TRACe:HOFFSet

Description:	Set or return the statistical mode horizontal scale offset in dB. The offset value will appear at the leftmost edge of the scale with units dBr (decibels relative).
Syntax:	DISPlay:TRACe[1|2|3|4]:HOFFSet <numeric_value>
Argument:	<numeric_value> = -50.00 to +50.00
Valid Modes:	Statistical

DISPlay:TRACe:HSCALe

Description:	Set or return the statistical mode horizontal scale in dB/Div.
Syntax:	DISPlay:TRACe[1|2|3|4]:HSCALe <numeric_value>
Argument:	<numeric_value> = 0.1 to 5.0 in a 1-2-5 sequence Valid Modes: Statistical

DISPlay:TRACe:VCENTer

Description:	Set or return the power or voltage level of the horizontal centerline of the graph for the specified channel in channel units. If a change in the vertical scale causes the center maximum value to be exceeded, the center will be forced to the maximum value for the new range.
Syntax:	DISPlay:TRACe[1|2|3|4]:VCENTer <numeric_value>
Argument:	<numeric_value> = –200.00 to +200.00 for dBm units ± 10,000 times the vertical scale power/div for watts units ± 10,000 times the vertical scale volts/div for volts units
Valid Modes:	All

DISPlay:TRACe:VSCALe

Description:	Set or return the power or voltage vertical sensitivity of the trace display in channel units.
Syntax:	DISPlay:TRACe[1|2|3|4]:VSCALe <numeric_value>
Argument:	Units = dBm, dBV, dBmV, dBuV , <numeric_value> = range in dB/division Units = watts <numeric_value> = range in watts/division Units = volts <numeric_value> = range in volts/division
Valid Modes:	All

5-7 FETCh Queries

The FETCh? group of queries is used to return specific measurement data from a measurement cycle that has been INITiated and is complete or free-running. FETCh? performs the data output portion of the measurement. FETCh? does not start a new measurement, so a series of FETCh? queries may be used to return more than one set of processed measurements from a complete set of acquired data. FETCh? usually returns the current value of measurements, and should be used anytime free running data acquisition is taking place (INITiate:CONTinuous ON).

FETCh:ARRay:AMEAsure:POWer?

Description:	Returns an array of the current automatic amplitude measurements performed on a periodic pulse waveform. Measurements performed are: peak amplitude during the pulse, average amplitude over a full cycle of the pulse waveform, average amplitude during the pulse, IEEE top amplitude, IEEE bottom amplitude, overshoot, and droop. Units are the same as the channel's units. Note the pulse overshoot is returned in dB for logarithmic channel units, and percent for all other units. Also, the pulse "ON" interval used for peak andaveragecalculations is defined by the SENSe:PULSe:STARTGT and :ENDGT time gating settings. A full pulse (rise and fall) must be visible on the display to make average and peak pulse power measurements, and a full cycle of the waveform must be visible to calculate average cycle amplitude.
Syntax:	FETCh[1|2|3|4]:ARRay:AMEAsure:POWer?
Returns:	CC1, PulsePeak, CC2, PulseCycleAvg, CC3, PulseOnAvg, CC4, IEEE Top, CC5, IEEE Bot, CC6, Overshoot, CC7, Droop. Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse Mode only.
Restrictions:	Timebase must be set appropriately to provide measurements.

FETCh:ARRay:AMEAsure:STATistical?

Description:	Returns an array of the current automatic statistical measurements performed on a sample population. Measurements performed are: long term average, peak and minimum amplitude, peak-to-average ratio, amplitude at the CCDF percent cursor, statistical percent at the CCDF power cursor, and the sample population size in samples. Note the peak-to-average ratio is returned in dB for logarithmic channel units, and percent for all other channel units.
Syntax:	FETCh[1|2|3|4]:ARRay:AMEAsure:STATistical?
Returns:	CC1, Pavg, CC2, Ppeak, CC3, Pmin, CC4, PkToAvgRatio, CC5, CursorPwr, CC6, CursorPct, CC7, Sample-Count Where the CCn's are the measurement condition codes for each measurement.
Valid Modes	Statistical Mode only

FETCh:ARRay:AMEAsure:TIMe?

Description:	Returns an array of the current automatic timing measurements performed on a periodic pulse waveform. Measurements performed are: the frequency, period, width, offtime and duty cycle of the pulse waveform, and the risetime and falltime of the edge transitions. For each of the measurements to be performed, the appropriate items to be measured must be visible on the display in GRAPH mode. Pulse frequency, period, offtime and duty cycle measurements require that an entire cycle of the pulse waveform (minimum of three edge transitions) be present. Pulse width measurement requires that at least one full pulse is visible and is most accurate if the pulse width is at least 0.4 divisions (20 pixels). Risetime and falltime measurements require that the edge being measured is visible and will be most accurate if the transition takes at least 0.1 divisions (5 pixels). It is always best to have the power meter set on the fastest timebase possible that meets the edge visibility restrictions. Set the trace averaging as high as practical to reduce fluctuations and noise in the pulse timing measurements. Note that the timing of the edge transitions is defined by the settings of the SENSe:PULSe:DISTal, :MESIal and :PROXimal settings; see the descriptions for those commands. Units are the same as the channel's units.
Syntax:	FETCh[1|2|3|4]:ARRay:AMEAsure:TIMe?
Returns:	CC1, PulseFreq, CC2, PulsePeriod, CC3, PulseWidth, CC4, Offtime, CC5, DutyCycle, CC6, Risetime, CC7, Falltime, CC8, EdgeDly, CC9, Skew in seconds Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse Mode only
Restrictions:	Timebase must be set appropriately to provide measurements (see above)

FETCh:ARRay:CW:POWer?

Description:	Note that the values for maximum and minimum power will depend on the peak hold mode; see the description of the CALCulate:PKHLD command for details.
Syntax:	FETCh[1|2|3|4]:ARRay:CW:POWer?
Returns:	CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse and Modulated

FETCh:ARRay:MARKer:POWer?

Description:	Returns an array of the current marker measurements for the specified channel. The array consists of the average, maximum, and minimum power and peak-to-average ratio between the two markers, powers at both markers, and the ratio of the two markers. Note the peak-to-average ratio and marker ratio are returned in dB for log units, and percent for linear units.
Syntax:	FETCh[1|2|3|4]:ARRay:MARKer:POWer?
Returns:	CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio, CC5, Pwr@Marker1, CC6, Pwr@Marker2, CC7, Mrk1/Mrk2 ratio Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse and Modulated

FETCh:CW:POWer?

Description:	Return current average amplitude reading in channel units. Syntax: FETCh[1|2|3|4]:CW:POWer?
Returns:	CC, average power (watts, dBm) or average voltage (volts, dBv) Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:AVERage?

Description:	For the specified channel, return the average power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:INTERval:AVERage?
Returns:	CC, average power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MAXFilt?

Description:	For the specified channel, return the maximum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:INTERval:MAXFilt?
Returns:	CC, maximum filtered power or voltage between the markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MINFilt?

Description:	For the specified channel, return the minimum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:INTERval:MINFilt?
Returns:	CC, minimum filtered power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MAXimum?

Description:	For the specified channel, return the maximum instantaneous power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:INTERval:MAXimum?
Returns:	CC, maximum instantaneous power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:MINimum?

Description:	For the specified channel, return the minimum instantaneous power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:INTERval:MINimum?
Returns:	CC, minimum instantaneous power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:INTERval:PKAVG?

Description:	For the specified channel, return the peak-to-average ratio of the power or voltage between marker 1 and marker 2. The units are dB for logarithmic channel units or percent for linear channel units.
Syntax:	FETCh[1|2|3|4]:INTERval:PKAVG?
Returns:	CC, peak-to-average ratio of power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

FETCh:MARKer:AVERage?

Description:	For the specified channel and marker, return the average power or voltage at the marker. The units are the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:MARKer[1|2]:AVERage? Returns: CC, average power or voltage at marker Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated.

FETCh:MARKer:CURsor:PERcent?

Description:	Return the CCDF cursor y-axis position in percent with respect to the value set by MARKer:POSItion:POWer (CCDF cursor mode is Power Ref). If CCDF cursor mode is Percent, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. Refer to the ML2439A Instruction Manual Statistical Mode Automatic Measurements section for more information.
Syntax:	FETCh[1|2|3|4]:MARKer:CURsor:PERcent?
Returns:	CC, percent CCDF Where CC is the measurement condition code.
Valid Modes:	Statistical.

FETCh:MARKer:CURsor:POWer?

Description:	Return the CCDF cursor x-axis position in relative power with respect to the value set by MARKer:POSItion:PERcent (CCDF cursor mode is Percent). If CCDF cursor mode is Power Ref, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. Refer to the ML2439A Instruction Manual Statistical Mode Automatic Measurements section for more information.
Syntax:	FETCh[1|2|3|4]:MARKer:CURsor:POWer? Returns: CC, relative power (dBr) CCDF Where CC is the measurement condition code.
Valid Modes:	Statistical

FETCh:MARKer:DELTa?

Description:	For the specified channel return the difference between MK1 and MK2. The units will be the same as marker units.
Syntax:	FETCh[1|2|3|4]:MARKer:DELTa? Returns: CC, (MK1 – MK2). Where CC is the measurement condition code. Valid Modes: All

FETCh:MARKer:MAXimum?

Description:	For the specified channel and marker, return the maximum power or voltage at the marker. The units are the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:MARKer[1|2]:MAXimum? Returns: CC, maximum power or voltage at marker Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated.

FETCh:MARKer:MINimum?

Description:	For the specified channel and marker, return the minimum power or voltage at the marker. The units will be the same as the specified channel.
Syntax:	FETCh[1|2|3|4]:MARKer[1|2]:MINimum? Returns: CC, minimum power or voltage at marker Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated.

FETCh:MARKer:RATio?

Description:	For the specified channel return the ratio of MK1 to MK2. The units will be dB for logarithmic units or percent for linear units.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:AVErage? ? <index>,<count>
Returns:	Avg(index), Avg(index+1), Avg(index+2)… Avg(index+count-1).
Valid Modes:	Pulse

FETCh#:MBUF:DATa:AVErage:ALL?

Description:	Query the power meter for all buffered average power measurements on the channel specified that were captured during the last SENSe:MBUF:ACQuire? query.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:AVErage:ALL?
Returns:	Avg(index), Avg(index+1), Avg(index+2)…
Valid Modes:	Pulse

FETCh#:MBUF:DATa:DURation?

Description:	Query the power meter for a list of duration measurements that were captured during the last SENSe:MBUF:ACQuire? query. The array will consist of <count> measurement values beginning at measurement number <index>.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:DURation? <index>,<count>
Returns:	Duration(index), Duration(index+1), Duration(index+2)… Duration(index+count-1).
Valid Modes:	Pulse

FETCh#:MBUF:DATa:DURation:ALL?

Description:	Query the power meter for all buffered durations on the channel specified that were captured during the last SENSe:MBUF:ACQuire? query.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:DURation:ALL?
Returns:	Duration(index), Duration(index+1), Duration(index+2)….
Valid Modes:	Pulse

FETCh#:MBUF:DATa:MAXimum?

Description:	Query the power meter for a list of maximum power measurements that were captured during the last SENSe:MBUF:ACQuire? query. The array will consist of <count> measurement values beginning at measurement number <index>.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:MAXimum? <index>,<count>
Returns:	Max(index), Max(index+1), Max(index+2)…Max(index+count-1).
Valid Modes:	Pulse

FETCh#:MBUF:DATa:MAXimum:ALL?

Description:	Query the power meter for all buffered maximum power measurements on the channel specified that were captured during the last SENSe:MBUF:ACQuire? query.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:MAXimum:ALL?
Returns:	Max(index), Max(index+1), Max(index+2)…
Valid Modes:	Pulse

FETCh#:MBUF:DATa:MINimum?

Description:	Query the power meter for a list of minimum power measurements that were captured during the last SENSe:MBUF:ACQuire? query. The array will consist of <count> measurement values beginning at measurement number <index>.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:MINimum? <index>,<count>
Returns:	Min(index), Min(index+1), Min(index+2)… Min(index+count-1).
Valid Modes:	Pulse

FETCh#:MBUF:DATa:MINimum:ALL?

Description:	Query the power meter for all buffered minimum power measurements on the channel specified that were captured during the last SENSe:MBUF:ACQuire? query.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:MINimum:ALL?
Returns:	Min(index), Min(index+1), Min(index+2)…
Valid Modes:	Pulse

FETCh#:MBUF:DATa:STARt?

Description:	Query the power meter for a list of start times in seconds that were captured during the last SENSe:MBUF:ACQuire? query. The array will consist of <count> measurement values beginning at measurement number <index>.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:STARt? <index>,<count>?
Returns:	Start_Time(index), Start_Time(index+1), Start_Time(index+2)…Start_Time(index+count-1)
Valid Modes:	Pulse

FETCh#:MBUF:DATa:STARt:ALL?

Description:	Query the power meter for all buffered start times in seconds on the channel specified that were captured during the last SENSe:MBUF:ACQuire? query.
Syntax:	FETCh[1|2|3|4]:MBUF:DATa:STARt:ALL?
Returns:	Start_Time(index), Start_Time(index+1), Start_Time(index+2)…
Valid Modes:	Pulse

FETCh:TEMPerature:AVERage?

Description:	Return the average internal temperature of the specified power sensor. Syntax: FETCh[1|2|3|4]:TEMPerature:AVERage?
Returns:	CC, Sensor[1|2|3|4] Average Temp in degrees C Where CC is the measurement condition code.
Valid Modes:	MA244xxA Sensors only

FETCh:TEMPerature:CURRent?

Description:	Return the current internal temperature of the specified power sensor. Syntax: FETCh[1|2|3|4]:TEMPerature:CURRent?
Returns:	CC, Sensor[1|2|3|4] Temp in degrees C Where CCn is the measurement condition code.
Valid Modes:	MA244xxA Sensors only

5-8 INITiate and ABORt Commands

The purpose of the INITiate group of commands is to start and control the process of data acquisition once a measurement has been configured. Depending on settings, the ML2439A USB Power Meter may be commanded to begin either a single measurement (INITiate:CONTinuous OFF) which stops when complete, or enter a “free-run” mode where data acquisition occurs continuously (INITiate:CONTinuous ON). The ABORt command terminates any operation in progress and prepares the instrument for an INITiate command. In some operating modes, the INITiate commands do not actually start measurements, but rather arms a hardware trigger, which is then used to gate the actual measurements cycle.

ABORt

Description:	Terminates any measurement in progress and resets the state of the trigger system. Note that ABORt will leave the measurement in a stopped condition with all current measurements cleared, and forces INITiate:CONTinuous to OFF.
Syntax:	ABORt
Argument:	None Valid Modes: Any

INITiate:CONTinuous

Description:	Set or return the data acquisition mode for single or free-run measurements. If INITiate:CONTinuous is set to ON, the ML2439A immediately begins taking measurements (Modulated, CW and Statistical Modes), or arms its trigger and takes a measurement each time a trigger occurs (Pulse Mode). If set to OFF, the measurement will begin (or be armed) as soon as the INITiate command is issued, and will stop once the measurement criteria (averaging, filtering or sample count) has been satisfied. Note that INITiate:IMMediate and READ commands are invalid when INITiate:CONTinuous is set to ON; however, by convention this situation does not result in a SCPI error.
Syntax:	INITiate:CONTinuous <Boolean> Argument:<Boolean> = { 0, 1, OFF, ON } Valid Modes:Any

INITiate[:IMMediate[:ALL]]

Description:	Starts a single measurement cycle when INITiate:CONTinuous is set to OFF. In Modulated Mode, the measurement will complete once the power has been integrated for the full FILTer time. In Pulse Mode, enough trace sweeps must be triggered to satisfy the AVERaging setting. In Statistical Mode, acquisition stops once the terminal condition(s) are met. In each case, no reading will be returned until the measurement is complete. This command is not valid when INITiate:CONTinuous is ON, however, by convention this situation does not result in a SCPI error.
Syntax:	INITiate[:IMMediate[:ALL]]
Argument:	None Valid Modes: Any
Restrictions:	INITiate:CONTinuous must be OFF

5-9 MARKer Subsystem

The MARKer group of commands is used to configure and locate measurement markers (cursors) at specific points on the processed measurement waveform. FETCH? or READ? queries may then be used to retrieve measurements at the two markers and in the interval between them. Markers are used in Pulse Mode to perform measurements at or between two time offsets relative to the trigger, and in

Statistical Mode to measure the power at a particular statistical percent, or the percent at a specified power level. In Pulse Mode, the markers can only be placed on the visible portion of the trace (as defined by the timebase and trigger delay settings), while Statistical Mode markers may be placed at any power or percent value and will still return readings.

MARKer:POSItion:PERcent

Description:	Set or return the percent probability (y-axis-position) of the CCDF cursor. Changing this setting will force the CCDF cursor mode to Percent for display purposes.
READ:	MARKer:CURsor:POWer? and FETCh:MARKer:CURsor:POWer? commands are referenced to this value.
Syntax:	MARKer:POSItion:PERcent? <numeric_value> Argument:<numeric_value> = 0.000 to 100.000
Valid Modes:	Statistical Modes only

MARKer:POSItion:POWer

Description:	Set or return the cumulative relative power (x-axis-position) of the CCDF cursor in dBr. Changing this setting will force the CCDF cursor mode to Power Ref for display purposes. READ:MARKer:CURsor:PERcent? and FETCh:MARKer:CURsor:PERcent? commands are referenced to this value.
Syntax:	MARKer:POSItion:POWer? <numeric_value> Argument: <numeric_value> = -100.000 to 100.000Valid Modes: Statistical Modes only

MARKer:POSItion:TIMe

Description:	Set or return the time (x-axis-position) of the selected marker relative to the trigger. Note that time markers must be positioned within the time limits of the trace window in the graph display. If a time outside of the display limits is entered, the marker will be placed at the first or last time position as appropriate.
Syntax:	MARKer[1|2]:POSItion:TIMe <numeric_value>
Argument:	<numeric_value> = display-time in seconds (see restrictions) Valid Modes:Pulse and Modulated Modes
Restrictions:	For zero delay trigger position in the center of the display , the following relationship must be satisfied: TrigDly - (5*time/div) < MarkerTime < TrigDly + (5*time/div) where the timebase setting is time/div

5-10 MEASure Queries

The MEASure group of commands is used to acquire data using a set of high level instructions. They are structured to provide trade-off fine control of the measurement process for easy operability. MEASure? provides a complete capability where the power meter is configured, a measurement taken, and results returned in one operation. The instrument is set to a basic, predefined measurement state with little user intervention necessary or possible. Sometimes, more precise control of measurement is required. In these cases, MEASure? should not be used. Rather, a sequence of configuration commands, generally from the CALCulate and SENSe groups should be used to set up the instrument for the measurement, then READ? or FETCH? commands are used to return the desired measurement data in a specific format.

MEMory:SNSR:CFFAST?

Description:	Return the sensor high bandwidth (FAST) frequency cal-factor table.
Syntax:	MEMory:SNSR[1|2|3|4]:CFFAST?
Returns:	None, query only.
Valid Modes:	Any

MEMory:SNSR:CFSLOW?

Description:	Return the sensor low bandwidth (SLOW) frequency cal-factor table.
Syntax:	MEMory:SNSR[1|2|3|4]:CFSLOW?
Argument:	None, query only.
Valid Modes:	Any

5-11 READ Queries

The purpose of the READ? group of queries is to initiate a measurement cycle, acquire data, and return specific measurement data. READ? performs the initiation, data acquisition, postprocessing, and data output portions of the measurement. READ? is equivalent to ABORting any operation in progress, INITiating a new measurement, then FETChing the data when it is ready. READ? generally does not return data unless acquisition is complete. Since READ? INITiates a new measurement every time it is issued, READ? queries should not be used for free running data acquisition (INITiate:CONTinuous ON) - in this case, use FETCh queries instead. For CW and Modulated Modes, the measurement is generally considered complete when the integration filter (see SENSe:FILTer) is filled. In Pulse Mode, the measurement is considered complete when all the number of complete traces specified by the SENSe:AVERage command have been acquired and averaged together. In Statistical Mode, the measurement is considered complete when the number of samples specified by TRIGger:CDF:COUNt has been gathered.

READ:ARRay:AMEAsure:POWer?

Description:	Returns an array of the current automatic amplitude measurements performed on a periodic pulse waveform. Measurements performed are: peak amplitude during the pulse, average amplitude over a full cycle of the pulse waveform, average amplitude during the pulse, IEEE top amplitude, IEEE bottom amplitude, overshoot, and droop. Units are the same as the channel's units. Note the pulse overshoot is returned in dB for logarithmic channel units, and percent for all other units. Also, the pulse "ON" interval used for peak and average calculations is defined by the SENSe:PULSe:STARTGT and :ENDGT time gating settings. A full pulse (rise and fall) must be visible on the display to make average and peak pulse power measurements, and a full cycle of the waveform must be visible to calculate average cycle amplitude.
Syntax:	READ[1|2|3|4]:ARRay:AMEAsure:POWer?
Returns:	CC1, PulsePeak, CC2, PulseCycleAvg, CC3, PulseOnAvg, CC4, IEEE Top, CC5, IEEE Bot, CC6, Overshoot, CC7, Droop Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse Mode only
Restrictions:	Timebase must be set appropriately to provide measurements (see above)

READ:ARRay:AMEAsure:STATistical?

Description:	Returns an array of the current automatic statistical measurements performed on a sample population. Measurements performed are: long term average, peak and minimum amplitude, peak-to-average ratio, amplitude at the CCDF cursor, statistical percent at the CCDF cursor, and the sample population size in samples. Note the peak- to-average ratio is returned in dB for logarithmic channel units, and percent for all other channel units.
Syntax:	READ[1|2|3|4]:ARRay:AMEAsure:STATistical?
Returns:	CC1, Pavg, CC2, Ppeak, CC3, Pmin, CC4, PkToAvgRatio, CC5, CursorPwr, CC6, CursorPct, CC7, Sample-Count Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Statistical Mode only

READ:ARRay:AMEAsure:TIMe?

Description:	Returns an array of the current automatic timing measurements performed on a periodic pulse waveform. Measurements performed are: the frequency, period, width, offtime and duty cycle of the pulse waveform, and the risetime and falltime of the edge transitions. For each of the measurements to be performed, the appropriate items to be measured must be visible on the display in GRAPH mode. Pulse frequency, period, offtime and duty cycle measurements require that an entire cycle of the pulse waveform (minimum of three edge transitions) be present. Pulse width measurement requires that at least one full pulse is visible, and is most accurate if the pulse width is at least 0.4 divisions (20 pixels). Risetime and falltime measurements require that the edge being measured is visible, and will be most accurate if the transition takes at least 0.1 divisions (5 pixels). It is always best to have the power meter set on the fastest timebase possible that meets the edge visibility restrictions. Set the trace averaging as high as practical to reduce fluctuations and noise in the pulse timing measurements. Note that the timing of the edge transitions is defined by the settings of the SENSe:PULSe:DISTal, :MESIal and :PROXimal settings; see the descriptions for those commands. Units are the same as the channel's units.
Syntax:	READ[1|2|3|4]:ARRay:AMEAsure:TIMe?
Returns:	CC1, PulseFreq, CC2, PulsePeriod, CC3, PulseWidth, CC4, Offtime, CC5, DutyCycle, CC6, Risetime, CC7, Falltime, CC8, EdgeDly, CC9, Skew in Hz Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse Mode only.
Restrictions:	Timebase must be set appropriately to provide measurements (see above)

READ:ARRay:CW:POWer?

Description:	Returns the current average, maximum, minimum powers or voltages and the peak-to- average ratio of the specified channel. Units are the same as the channel's units. Note the peak-to-average ratio and marker ratio are returned in dB for logarithmic channel units, and percent for all other channel units. Note that the values for maximum and minimum power will depend on the peak hold mode; see the description of the CALCulate:PKHLD command for details.
Syntax:	READ[1|2|3|4]:ARRay:CW:POWer?
Returns:	CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse and Modulated

READ:ARRay:MARKer:POWer?

Description:	Returns an array of the current marker measurements for the specified channel. The array consists of the average, maximum, and minimum power and peak-to-average ratio between the two markers, powers at both markers, and the ratio of the two markers. Note the peak-to-average ratio and marker ratio are returned in dB for log units, and percent for linear units.
Syntax:	READ[1|2|3|4]:ARRay:MARKer:POWer?
Returns:	CC1, Pavg, CC2, Pmax, CC3, Pmin, CC4, PkToAvgRatio, CC5, Pwr@Marker1, CC6, Pwr@Marker2, CC7, Mrk1/Mrk2 ratio Where the CCn's are the measurement condition codes for each measurement.
Valid Modes:	Pulse and Modulated

READ:CW:POWer?

Description:	Return current average amplitude reading in channel units. Syntax: READ[1|2|3|4]:CW:POWer?
Returns:	CC, Average power (watts, dBm) or average voltage (volts, dBv) Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:INTERval:AVERage?

Description:	For the specified channel, return the average power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	READ[1|2|3|4]:INTERval:AVERage?
Returns:	CC, average power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:INTERval:MAXFilt?

Description:	For the specified channel, return the maximum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	READ[1|2|3|4]:INTERval:MAXFilt?
Returns:	CC, maximum filtered power or voltage between the markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:INTERval:MINFilt?

Description:	For the specified channel, return the minimum filtered power or voltage in the time interval between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	READ[1|2|3|4]:INTERval:MINFilt?
Returns:	CC, minimum filtered power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:INTERval:MAXimum?

Description:	For the specified channel, return the maximum instantaneous power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	READ[1|2|3|4]:INTERval:AVERage?
Returns:	CC, maximum instantaneous power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:INTERval:MINimum?

Description:	For the specified channel, return the minimum instantaneous power or voltage between marker 1 and marker 2. The units will be the same as the specified channel.
Syntax:	READ[1|2|3|4]:INTERval:MINimum?
Returns:	CC, minimum instantaneous power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:INTERval:PKAVG?

Description:	For the specified channel, return the peak-to-average ratio of the power or voltage between marker 1 and marker 2. The units are dB for logarithmic channel units or percent for linear channel units.
Syntax:	READ[1|2|3|4]:INTERval:PKAVG?
Returns:	CC, peak-to-average ratio of power or voltage between markers Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:MARKer:AVERage?

Description:	For the specified channel and marker, return the average power or voltage at the marker. The units are the same as the specified channel.
Syntax:	READ[1|2|3|4]:MARKer[1|2]:AVERage?
Returns:	CC, average power or voltage at marker Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated

READ:MARKer:DELTa?

Description:	For the specified channel return the difference between MK1 and MK2. The units will be the same as marker units.
Syntax:	READ[1|2|3|4]:MARKer:DELTa?
Returns:	CC, (MK1 – MK2) Where CC is the measurement condition code.
Valid Modes:	All

READ:MARKer:MAXimum?

Description:	For the specified channel and marker, return the maximum power or voltage at the marker. The units are the same as the specified channel.
Syntax:	READ[1|2|3|4]:MARKer[1|2]:MAXimum?
Returns:	CC, maximum power or voltage at marker Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated.

READ:MARKer:MINimum?

Description:	For the specified channel and marker, return the minimum power or voltage at the marker. The units will be the same as the specified channel.
Syntax:	READ[1|2|3|4]:MARKer[1|2]:MINimum?
Returns:	CC, minimum power or voltage at marker Where CC is the measurement condition code.
Valid Modes:	Pulse and Modulated.

READ:MARKer:CURsor:PERcent?

Description:	Return the CCDF cursor y-axis position in percent with respect to the value set by MARKer:POSItion:POWer (CCDF cursor mode is set to Power Ref). If CCDF cursor mode is Percent, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. Refer to the ML2439A Instruction Manual Statistical Mode Automatic Measurements section for more information.
Syntax:	READ[1|2|3|4]:MARKer:CURsor:PERcent?
Returns:	CC, percent CCDF Where CC is the measurement condition code.
Valid Modes:	Statistical.

READ:MARKer:CURsor:POWer?

Description:	Return the CCDF cursor x-axis position in relative power with respect to the value set by MARKer:POSItion:PERcent (CCDF cursor mode is set to Percent). If CCDF cursor mode is Power Ref, returns user setting. See MARKer:POSItion:POWer and MARKer:POSItion:PERcent. Refer to the ML2439A Instruction Manual Statistical Mode Automatic Measurements section for more information.
Syntax:	READ[1|2|3|4]:MARKer:CURsor:POWer?
Returns:	CC, relative power (dBr) CCDF Where CC is the measurement condition code.
Valid Modes:	Statistical

READ:MARKer:RATio?

Description:	For the specified channel return the ratio of MK1 to MK2. The units will be dB for logarithmic units or percent for linear units.
Syntax:	READ[1|2|3|4]:Marker:RATio?
Returns:	CC, MK1/MK2 Where CC is the measurement condition code.
Valid Modes:	All

READ:MARKer:RDELTa?

Description:	For the specified channel return the difference between MK2 and MK1. The units will be the same as marker units.
Syntax:	READ[1|2|3|4]:MARKer:RDELTa?
Returns:	CC, (MK2-MK1) Where CC is the measurement condition code.
Valid Modes:	All

READ:MARKer:RRATio?

Description:	For the specified channel return the ratio of MK2 to MK1. The units will be dB for logarithmic units or percent for linear units..
Syntax:	READ[1|2|3|4]:MARKer:RRATio?
Returns:	CC, MK2/MK1 Where CC is the measurement condition code.
Valid Modes:	All

5-12 SENSe Subsystem

The purpose of the SENSe command subsystem is to directly configure device specific settings used to make measurements, generally parameters related to the RF power sensor and signal processing. The SENSe commands are used to configure the power meter for acquiring data. SENSe enables you to change measurement parameters such as filtering or averaging, sensor bandwidth, operating frequency and calfactors, and measurement gain or offset. The numeric suffix of the SENSe program mnemonic in the SENSe commands refers to a hardware measurement “channel” that is SENSe1 and SENSe2 represent the instrument’s SENSOR 1 and SENSOR 2 signal paths, respectively. The SENSe commands generally DO NOT affect the data processing and display portion of the measurement (see the CALCulate subsystem).

SENSe:AVERage

Description:	Set or return the number of traces averaged together to form the measurement result on the selected channel. Averaging can be used to reduce display noise on both the visible trace, and on marker and automatic pulse measurements. Trace averaging is a continuous process in which the measurement points from each sweep are weighted (multiplied) by an appropriate factor, and averaged into the existing trace data points. In this way, the most recent data will always have the greatest effect on the trace shape, and older measurements will be decayed at a rate determined by the averaging setting and trigger rate. Note that for timebase settings of 500 ns/div and faster, the ML2439A acquires samples using a technique called equivalent time or interleaved sampling. In this mode, not every pixel on the trace gets updated on each sweep, and the total number of sweeps needed to satisfy the AVERage setting will be increased by the sample interleave ratio of that particular timebase.
Syntax:	SENSe[1|2|3|4]:AVERage <numeric_value>
Argument:	<numeric_value> = Numeric_value from 1 to 16,384 (1 = no trace averaging)
Valid Modes:	Pulse

SENSe:BANDwidth

Description:	Set or return the sensor video bandwidth for the selected sensor or the trigger channel bandwidth if a trigger channel is selected. HIGH is the normal setting for most measurements. The actual bandwidth is determined by the peak sensor model used. Use LOW bandwidth for additional noise reduction when measuring CW or signals with very low modulation bandwidth. If LOW bandwidth is used on signals with fast modulation, measurement errors will result because the sensor cannot track the fast changing envelope of the signal.
Syntax:	SENSe[1|2|3|4]:BANDwidth <character data>
Argument:	<character data> = { LOW, HIGH }
Valid Modes:	All

SENSe:CORRection:CALFactor

Description:	Set or return the frequency calfactor currently in use on the selected channel. Note setting a calfactor with this command will override the “automatic” frequency calfactor that was calculated and applied when the operating frequency was set, and setting the operating frequency will override this calfactor setting.
Syntax:	SENSe[1|2|3|4]:CORRection:CALFactor <numeric_value>
Argument:	<numeric_value> = –3.00 to 3.00 dB, units are optional
Valid Modes:	All

SENSe:CORRection:DCYCle

Description:	Set or return the duty cycle correction factor in percent currently in use on the selected channel. Syntax:SENSe[1|2|3|4]:CORRection:DCYCle
Argument:	<numeric_value> = 0.01 to 100.00
Valid Modes:	CW Sensor (Modulated Mode)

SENSe:CORRection:FREQuency

Description:	Set or return the RF frequency for the current sensor, and apply the appropriate frequency calfactor from the sensor's EEPROM table. Application of this calfactor cancels out the effect of variations in the flatness of the sensor's frequency response. If an explicit calfactor has been set, either manually or via the SENSe:CORRection:CALFactor command, entering a new frequency will override this calfactor and use only the "automatic" frequency calfactor.
Syntax:	SENSe[1|2|3|4]:CORRection:FREQuency <numeric_value>
Argument:	<numeric_value> = 1e6 to 110.0e9 Hz (actual sensor may have narrower range; range may depend on channel bandwidth setting)
Valid Modes:	All

SENSe:CORRection:OFFSet

Description:	Set or return a measurement offset in dB for the selected sensor. This is used to compensate for external couplers, attenuators or amplifiers in the RF signal path ahead of the power sensor.
Syntax:	SENSe[1|2|3|4]:CORRection:OFFSet <numeric_value>
Argument:	<numeric_value> = –200.000 to 200.000 dB units are optional.
Valid Modes:	Any

SENSe:FILTer:STATe

Description:	Set or return the current setting of the integration filter on the selected channel. OFF provides no filtering, and can be used at high signal levels when absolute minimum settling time is required. ON provides a user-specified integration time, from 2 milliseconds to 15 seconds (see SENSe:FILTer:TIMe command). Note that setting the filter time will force the state to ON. AUTO uses a variable amount of filtering, which is set automatically by the power meter based on the current signal level to a value that gives a good compromise between measurement noise and settling time at most levels.
Syntax:	SENSe[1|2|3|4]:FILTer:STATe <character data>
Argument:	<character data> = {OFF, ON, AUTO}
Valid Modes:	Modulated

SENSe:FILTer:TIMe

Description:	Set or return the current length of the integration filter on the selected channel. If the filter state is set to AUTO, querying the time will return -0.01, and if set to OFF, a time query will return 0.00. Note that setting the filter time will force the state to ON.
Syntax:	SENSe[1|2|3|4]:FILTer:TIMe <numeric_value>
Argument:	<numeric_value> = 0.002 to 16.000 in 2 millisecond increments
Valid Modes:	Modulated

SENSe:MBUF:ACQuire?

Description:	Starts a new measurement buffer acquisition. This command blocks communication until the number of measurements for each enabled channel is equal to count, a time out has occurred, or the buffer is overrun before it could be read into memory.
Syntax:	SENSe:MBUF:ACQuire?
Returns:	Stop Reason numeric code. 1 = Count Reached, 2 = Timed Out, 3 = Buffer Overrun.
Valid Modes:	Pulse

SENSe:MBUF:DELay:END

Description:	Set or return the time in seconds added to the detected end of a burst for analysis. Typically a negative value is used to exclude the falling edge of a burst from the measurement..
Syntax:	SENSe:MBUF:DELay:END <numeric value>
Argument:	<numeric value> = -10e-6 to 100e-3
Valid Modes:	Pulse

SENSe:MBUF:DELay:STARt

Description:	Set or return the time in seconds added to the detected beginning of a burst for analysis. Typically used to exclude the rising edge of a burst from the measurement.
Syntax:	SENSe:MBUF:DELay:STARt <numeric value>
Argument:	<numeric value> = -10e-6 to 100e-3
Valid Modes:	Pulse

SENSe:MBUF:ENABled:FLAG

Description:	Set or return the bit mask value indicating which MBUF arrays will be filled during a SENSe:MBUF:ACQuire? query.
Syntax:	SENSe:MBUF:ENABled <numeric value>
Argument:	<numeric value> = decimal value representing a 6-bit binary value used to enable/disable mask bits

BIT	VALUE	DEFINITION
5	32	Enable Sequence Capture
4	16	Enable Start Time Capture
3	8	Enable Duration Capture
2	4	Enable Min. Measurements
1	2	Enable Average Measurements
0	1	Enable Max. Measurements

Valid Modes:	5

SENSe:MBUF:GATe:MODe

Description:	Set or return the gate mode used to define the start and end of a measurement time interval.
Syntax:	SENSe:MBUF:GATe:MODe <character data>
Argument:	<character data> = {BURst, MARKer, EXTGATE, PERiodic, EXTTRIG}
Valid Modes:	Pulse

SENSe#:MBUF:MEASurements:AVAilable?

Description:	Gets the number of measurements available in the power meter’s internal buffer.
Syntax:	SENSe[1|2|3|4]:MBUF:MEASurements:AVailable?
Returns:	<numeric>
Valid Modes:	Pulse

SENSe:MBUF:MEASurements:CLEar

Description:	Clears all cached average, min, max, duration, start time, and sequence numbers.
Syntax:	SENSe:MBUF:MEASurements:CLEar
Argument:	None
Valid Modes:	Pulse

SENSe:MBUF:PERiod

Description:	Set or return the period in seconds, that each timed mode measurement is started. Refer to the “SENSe:MBUF:PERiod:DURation” command to set the duration of the measurement.
Syntax:	SENSe:MBUF:PERiod <numeric value>
Argument:	<numeric value> = 100e-9 to 10
Valid Modes:	Pulse

SENSe:MBUF:PERiod:DURation

Description:	Set or return the time duration in seconds, that samples are captured during each timed mode MBUF acquisiton.
Syntax:	SENSe:MBUF:PERiod:DURation <numeric value>
Argument:	<numeric value> = 0.001 to 1000
Valid Modes:	Pulse

SENSe:MBUF:QUALifier:END

Description:	Set or return the minimum amount of time in seconds power remains below the trigger point to be counted as the end of a burst.
Syntax:	SENSe:MBUF:QUALifier:END <numeric value>
Argument:	<numeric value> = 0.0 to 10e-6
Valid Modes:	Pulse

SENSe:MBUF:QUALifier:STARt

Description:	Set or return the minimum amount of time in seconds power remains above the trigger point to be counted as the beginning of a burst.
Syntax:	SENSe:MBUF:QUALifier:STARt <numeric value>
Argument:	<numeric value> = 0.0 to 10e-6
Valid Modes:	Pulse

SENSe:MBUF:SESsion:COUNt

Description:	Set or return the count of elements for the MBUF arrays during a SENSe:MBUF:ACQuire? query.
Syntax:	SENSe:MBUF:SESsion:COUNt <numeric data>
Argument:	<numeric data> = 1 to 999999
Valid Modes:	Pulse

SENSe:MBUF:SESsion:TIMEout

Description:	Set or return the maximum time in seconds for the MBUF session during a SENSe:MBUF:ACQuire? query.
Syntax:	SENSe:MBUF:SESsion:TIMEout <numeric value>
Argument:	<numeric value> = 1e-3 to 1e3
Valid Modes:	Pulse

SENSe:MBUF:START:MODe

Description:	Set or return the mode used to start acquiring MBUF entries.
Syntax:	SENSe:MBUF:GATe:MODe <character data>
Argument:	<character data> = {IMMediate, EXTEnable, EXTStart}
Valid Modes:	Pulse

SENSe:PULSe:DISTal

Description:	Set or return the pulse amplitude percentage, which is used to define the end of a rising edge or beginning of a falling edge transition. Typically, this is 90% voltage or 81% power relative to the “top level” of the pulse. This setting is used when making automatic pulse risetime and falltime calculations returned by READ:ARRay:AMEASure:POWer.
Syntax:	SENSe[1|2|3|4]:PULSe:DISTal <numeric_value>
Argument:	<numeric_value> = 50.00 to 100.00
Valid Modes:	Pulse Mode only

SENSe:PULSe:ENDGT

Description:	Set or return the point on a pulse, which is used to define the end of the pulse's "active" interval. This point is defined in percent of the total pulse duration, with 0% corresponding to the midpoint of the rising edge, and 100% corresponding to the midpoint of the falling edge, as defined by the mesial setting. For most pulse "on" average power measurements, it is desirable to exclude the rising and falling intervals, and only measure power over the active portion of the pulse. This is often known as time gating, and is used for the automatic pulse measurements returned by READ:ARRay:AMEASure:POWer.
Syntax:	SENSe[1|2|3|4]:PULSe:ENDGT <numeric_value>
Argument:	<numeric_value> = 60.00 to 100.00
Valid Modes:	Pulse Mode only

SENSe:PULSe:MESIal

Description:	Set or return the pulse amplitude percentage, which is used to define the midpoint of a rising or falling edge transition. Typically, this is 50% voltage or 25% power relative to the "top level" of the pulse. This setting is used when making automatic pulse width and duty cycle calculations returned by FETCh:ARRay:AMEASure:POWer.
Syntax:	SENSe[1|2|3|4]:PULSe:MESIal <numeric_value>
Argument:	<numeric_value> = 10.00 to 90.00
Valid Modes:	Pulse Mode only

SENSe:PULSe:PROXimal

Description:	Set or return the pulse amplitude percentage, which is used to define the beginning of a rising edge or end of a falling edge transition. Typically, this is 10% voltage or 1% power relative to the "top level" of the pulse. This setting is used when making automatic pulse risetime and falltime calculations returned by FETCh:ARRay:AMEASure:POWer.
Syntax:	SENSe[1|2|3|4]:PULSe:PROXimal <numeric_value>
Argument:	<numeric_value> = 0.00 to 50.00
Valid Modes:	Pulse Mode only

SENSe:PULSe:STARTGT

Description:	Set or return the point on a pulse, which is used to define the beginning of the pulse's "active" interval. This point is defined in percent of the total pulse duration, with 0% corresponding to the midpoint of the rising edge, and 100% corresponding to the midpoint of the falling edge, as defined by the mesial setting. For most pulse "on" average power measurements, it is desirable to exclude the rising and falling intervals, and only measure power over the active portion of the pulse. This is often known as time gating, and is used for the automatic pulse measurements returned by FETCh:ARRay:AMEASure:POWer.
Syntax:	SENSe[1|2|3|4]:PULSe:STARTGT <numeric_value>
Argument:	<numeric_value> = 0.00 to 40.00
Valid Modes:	Pulse Mode only

SENSe:PULSe:UNIT

Description:	Set or return the units for entering the pulse distal, mesial and proximal levels. If the function is set to VOLTS, the pulse transition levels will be defined as the specified percentage in voltage. If set to WATTS, the levels are defined in percent power. Many pulse measurements call for 10% to 90% voltage (which equates to 1% to 81% power) for risetime and falltime measurements, and measure pulse widths from the half-power (–3dB, 50% power, or 71% voltage) points.
Syntax:	SENSe[1|2|3|4]:PULSe:UNIT <character data>
Argument:	<character data> = {WATTS, VOLTS}
Valid Modes:	Pulse Mode only

SENSe:SENSOR:TYPE?

Description:	Returns the sensor type for the selected channel.
Syntax:	SENSe[1|2|3|4]:SENSOR:TYPE?
Returns:	<character data> = { NONE, CW, VOLT, PEAK }
Valid Modes:	All

5-13 SYSTem Subsystem

The SYSTem group of commands is used to control system-level functions not directly related to instrument measurement performance. SYSTem commands are used to return error codes or messages from the power meter error queue, control hardware features (backlight and key beep), access the internal clock/calendar, and configure communication parameters for the GPIB and LAN interfaces.

SYSTem:BEEP[:ENABle]

Description:	Set or return the status of the audible keyboard beeper. Syntax: SYSTem:BEEP[:ENABle] <Boolean>
Argument:	<Boolean> = { 0, 1, OFF, ON }
Valid Modes:	Any

SYSTem:COMMunicate:GPIB:ADDRess

Description:	Set or return the GPIB bus address.
Syntax:	SYSTem:COMMunicate:GPIB:ADDRess <numeric_value>
Argument:	<numeric_value> = 1 to 30
Valid Modes:	Any

SYSTem:COMMunicate:LAN:ADDRess

Description:	Set or return the IP address for the Ethernet port.
Syntax:	SYSTem:COMMunicate:LAN:ADDRess <character data>
Argument:	<character data> = instrument IP address in nnn.nnn.nnn.nnn (“dot decimal”) format
Valid Modes:	Any for queries. DHCP/AutoIP must be disabled (OFF) to set the instrument IP address.

SYSTem:COMMunicate:LAN:DHCP

Description:	Set or return the state of DHCP/AutoIP system for the Ethernet port. If DHCP/AutoIP is enabled (1 | ON), the instrument will attempt to obtain its IP Address, Subnet Mask, and Default Gateway from a DHCP (dynamic host configuration protocol) server on the network. If no DHCP server is found, the instrument will select its own IP Address, Subnet Mask, and Default Gateway values using the “AutoIP” protocol. If DHCP/AutoIP is disabled (0 | OFF), the instrument will use the IP Address, Subnet Mask, and Default Gateway values that have been entered by the user.
Syntax:	SYSTem:COMMunicate:LAN:DHCP <Boolean>
Argument:	<Boolean> = { 0, 1, OFF, ON }
Valid Modes:	Any

SYSTem:ERRor[:NEXT]?

Description:	Returns the next queued error code number followed by a quoted ASCII text string describing the error. Note that errors are stored in a “first-in-first-out” queue, so if more than one error has occurred, repeating this command will report the errors in the sequence they happened. The action of reading an error removes that error from the queue, so once the most recent error has been read, further queries will report a code of zero, and “No Error”
Syntax:	SYSTem:ERRor[:NEXT]?
Returns:	<numeric error code>, “QUOTED ERROR DESCRIPTION”
Valid Modes:	Any

SYSTem:ERRor:CODE?

Description:	Returns the next queued error code number. Note that errors are stored in a “first-in-first-out” queue, so if more than one error has occurred, repeating this command will report the error codes in the sequence they happened. The action of reading an error removes that error from the queue, so once the most recent error has been read, any more queries will report a code of zero.
Syntax:	SYSTem:ERRor:CODE?
Returns:	<numeric error code>
Valid Modes:	Any

SYSTem:ERRor:COUNt?

Description:	Returns the number of errors that currently exist in the error queue. A value of 0 means that there are no errors in the queue. Therefore, either no errors have occurred, or all errors have been read.
Syntax:	SYSTem:ERRor:COUNt?
Returns:	<numeric error code>
Valid Modes:	Any

SYSTem:PRESet

Description:	Set ML2439A default parameters. Equivalent to selecting “Initialize” from Measure > Meas. Settings on the ML2439A meter.
Syntax:	SYSTem:PRESet
Argument:	None
Valid Modes:	Any

SYSTem:VERSion?

Description:	Return the SCPI version compliance claimed.
Syntax:	SYSTem:VERSion?
Returns:	<character data> = Version Code as <year.version> YYYY.V (will return 1999.0)
Valid Modes:	Any

5-14 TRACe Data Array Commands

The TRACe group of commands is used to control the output of an acquired measurement array, which appears as a display trace when the power meter is in Graph mode. The TRACe commands provide outputting a channel's entire internal display trace (501 measurement points) as one large array, or selecting and returning the array in smaller portions. These commands are useful for capturing the displayed waveform and importing it into a database on the host.

TRACe [:AVERage]]:DATA[:NEXT]?

Description:	Return a delimited array of power or voltage pixel average values corresponding to all or a portion of the graph mode display trace for the selected channel. The Average trace is the data shown when envelope display mode is inactive. Note that the pixel values are returned without regard to display vertical scale and center settings. The array will consist of COUNT trace pixel values, beginning at pixel number INDEX, up to the last pixel of the trace (index = 500), and will be returned in channel units. The selected channel must be "ON" to return measurement data.
Syntax:	TRACe[1|2|3|4][:AVERage]]:DATA[:NEXT]?
Returns:	P(index), P(index+1), P(index+2),…P(index+count) or V(index), V(index+1), V(index+2),…V(index+count)
Valid Modes:	All

TRACe:COUNt

Description:	Set or return the number of trace points, which will be returned each time the TRACe:DATA? query is issued. At the completion of each read, INDEX is automatically incremented by COUNT. If COUNT is set to a number greater than the number of points remaining in the trace, the array will be truncated. Setting COUNT to 501 (and INDEX to zero each time) will return the entire trace array.
Syntax:	TRACe[1|2|3|4]:COUNt <numeric_value>
Argument:	<numeric_value> = 1 to 501
Valid Modes:	All

TRACe:INDEX

Description:	Set or return the array index for the first trace point to be returned next time the TRACe:DATA? query is issued. Index 0 is the start of the trace buffer, and corresponds to the leftmost pixel on the graph display. Index 500 is the last point, and is the rightmost pixel. Each time a block of data is read, INDEX is automatically incremented by the COUNT value, so the full array can be split up into blocks of manageable size and read with successive TRACe:DATA? queries. INDEX must be reset to zero for each new trace that is to be dumped, whether or not all the points have been read.
Syntax:	TRACe[1|2|3|4]:INDEX <numeric_value>
Argument:	<numeric_value> = 0 to 500
Valid Modes:	All

5-15 TRIGger Subsystem

The TRIGger group of commands is used to control synchronization of data acquisition with external events. TRIGger commands generally affect only Pulse Mode.

TRIGger:CDF:COUNt

Description:	Set or return the terminal count (sample population size) in millions of samples for Statistical Mode acquisition. When the terminal count is reached, the CCDF is considered “complete”, and the instrument will halt acquisition if INITiate:CONTinuous is set to OFF. If INITiate:CONTinuous is ON, sample acquisition will continue in the manner specified by the TRIGger:CDF:DECImate setting.
Syntax:	TRIGger:CDF:COUNt <numeric_value>
Argument:	<numeric_value> = 1 to 4000
Valid Modes:	Statistical Mode only.

TRIGger:CDF:DECImate

Description:	Set or return the termination action when running continuously in Statistical Mode. This action occurs when the terminal count is reached (as defined by TRIGger:CDF:COUNt) or the terminal running time is reached (as defined by TRIGger:CDF:TIMe).
Syntax:	TRIGger:CDF:DECImate <DECIMATE, RESTART, STOP>
Argument:	<Boolean> = { DECIMATE, RESTART, STOP }
Valid Modes:	Statistical Mode only

TRIGger:CDF:TIMe

Description:	Set or return the terminal running time in seconds for Statistical Mode acquisition. When the terminal time is reached, the CCDF is considered “complete”, and the instrument will halt acquisition if INITiate:CONTinuous is set to OFF. If INITiate:CONTinuous is ON, sample acquisition will continue in the manner specified by the TRIGger:CDF:DECImate setting.
Syntax:	TRIGger:CDF:TIMe <numeric_value>
Argument:	<numeric_value> = 1 to 3600
Valid Modes:	Statistical Mode only

TRIGger:DELay

Description:	Set or return the trigger delay time in seconds with respect to the trigger for the trigger display location in the LEFT position. Positive values cause the actual trigger to occur after the trigger condition is met. This places the trigger event to the left of the trigger point on the display, and is useful for viewing events during a pulse, some fixed delay time after the rising edge trigger. Negative trigger delay places the trigger event to the right of the trigger point on the display, and is useful for looking at events before the trigger edge.
Syntax:	TRIGger:DELay <numeric_value>
Argument:	<numeric value> -378e-3 to 1250e-3, range varies with timebase setting
Valid Modes:	Pulse mode only

TRIGger:HOLDoff

Description:	Set or return the trigger holdoff time in seconds. Trigger holdoff is used to disable the trigger for a specified amount of time after each trigger event. The holdoff time starts immediately after each valid trigger edge, and will not permit any new triggers until the time has expired. When the holdoff time is up, the trigger re-arms, and the next valid trigger event (edge) will cause a new sweep. This feature is used to help synchronize the power meter with burst waveforms such as a TDMA or GSM frame. The trigger holdoff resolution is 10 nanoseconds, and it should be set to a time that is just slightly shorter than the frame repetition interval.
Syntax:	TRIGger:HOLDoff <numeric_value>
Argument:	<numeric_value> = 0.0 to 1.0 seconds in 10e-9 increments, 0.0 = no holdoff
Valid Modes:	Pulse mode only

TRIGger:LEVel

Description:	Set or return the trigger level for synchronizing data acquisition with a pulsed input signal or external trigger pulses. The internal trigger level entered should include any global offset and will also be affected by the frequency cal factor. The available internal trigger level range is sensor dependent. For internal trigger sources, the trigger level is set and returned in dBm. The external trigger is set and returned in volts. Note that there is a small amount of hysteresis built into the trigger system, and the signal should have at least one dB greater swing in each direction past the trigger level setting, and somewhat more at low levels. Note that explicitly setting the trigger level while TRIGger:MODe is set to AUTOPKPK will cancel the AUTOPKPK setting, and force the trigger mode back to AUTO. In AUTOPKPK the Trigger Level menu will display “AUTO LEVEL”.
Syntax:	TRIGger:LEVel <numeric_value>
Argument:	<numeric_value> = –40.0 to +20 (plus offset, if any) (internal trigger sources) <numeric_value> = +/-5.0 (external trigger)
Valid Modes:	Pulse mode only

TRIGger:MODE

Description:	Set or return the trigger mode for synchronizing data acquisition with pulsed signals. NORM mode will cause a sweep to be triggered each time the power level crosses the preset trigger level in the direction specified by TRIGger:SLOPe. If there are no edges that cross this level, no data acquisition will occur. AUTO mode operates in much the same way as NORM mode, but will automatically generate a trace if no trigger edges are detected for a period of time (100 to 500 milliseconds, depending on timebase). This will keep the trace updating even if the pulse edges stop. The AUTOPKPK mode operates the same as AUTO mode, but will adjust the trigger level to halfway between the highest and lowest power or voltage levels detected. This aids in maintaining synchronization with a pulse signal of varying level. Note that a setting of PKTOPK will be overridden and forced back to AUTO if a TRIGger:LEVel is set. The FREERUN mode force traces at a high rate to assist in locating the signal.
Syntax:	TRIGger:MODE <character data>
Argument:	<character data> = {AUTO, AUTOPKPK, NORMAL, FREERUN}
Valid Modes:	Pulse mode only

TRIGger:POSition

Description:	Set or return the position of the trigger event on displayed sweep. Assuming zero trigger delay, setting the position to LEFT causes the entire trace to be post-trigger. Setting it to RIGHT causes the entire trace to be pre-trigger. And setting to MIDDLE will display both the pre- and post- trigger portions of the trace. Note that the TRIGger:DELay setting is in addition to this setting, and will cause the trigger position to appear in a different location. Setting the trigger position places the ML2439A in trigger position mode, which overrides the variable vernier settings of the TRIGger:VERNier command.
Syntax:	TRIGger:POSition <character data>
Argument:	<character data> = {LEFT, MIDDLE, RIGHT}
Valid Modes:	Pulse mode only

TRIGger:SLOPe

Description:	Set or return the trigger slope or polarity. When set to POS, trigger events will be generated when a signal's rising edge crosses the trigger level threshold. When NEG, trigger events are generated on the falling edge of the pulse.
Syntax:	TRIGger:SLOPe <character data>
Argument:	<character data> = {NEG, POS}
Valid Modes:	Pulse mode only

TRIGger:SOURce

Description:	Set or return the trigger source used for synchronizing data acquisition. The CH1 and CH2 (2 channel ML2439A) settings use the signal from the associated sensor. EXT setting uses the signal applied to the rear panel TRIG IN connector.
Syntax:	TRIGger:SOURce <character data>
Argument:	<character data> = {CH1, CH2, CH3, CH4, IND, EXT}
Valid Modes:	Pulse mode only

TRIGger:VERNier

Description:	Set or return the fine position of the trigger event on displayed sweep. The position is given in divisions relative to the left edge of the screen, so with zero trigger delay, setting the vernier control to 0.0 causes the entire trace to be post-trigger. Setting it to 10.0 causes the entire trace to be pre-trigger. And setting to 5.0 will display both the pre- and post-trigger portions of the trace. Note that the TRIGger:DELay setting is in addition to this setting, and will cause the trigger position to appear in a different location. Setting the trigger vernier places the ML2439A in trigger vernier mode, which overrides the fixed "Left, Middle, Right" settings of the TRIGger:POSition command.

Syntax:	TRIGger:VERNier <numeric_value>
Argument:	<numeric_value> = –30.0 to 30.0
Valid Modes:	Pulse mode only

5-16 SCPI Command Reference

This section contains a list of all SCPI remote commands accepted by the ML2439A. The list is grouped by SCPI subsystem or IEEE488.2 function, and includes a detailed description of each command.

SCPI Command Summary

The SCPI command summary is provided in Table 5-1.

Table 5-1. SCPI Command Summary

*IDN	Identification Query
*OPC?	Operation Complete Query
*OPC	Operation Complete Command
*TST?	Self-Test Query
ABORt	Immediately set measurement trigger system to idle
CALCulate:MODE	Set/return instrument mode. <numeric_value> = PULSe, MODulated, STATistical
CALCulate[1|2|3|4]:PKHLD	Set/return state of the peak hold function. <Boolean> = OFF, AVG, INST
CALCulate[1|2|3|4]:STATe	Enable currently selected channel providing measurements to be made. <Boolean> = 0, 1, OFF, ON
CALCulate[1|2|3|4]:UNITs	Change channel units. <numeric_value> = DBM, Watts, Volts, DBV, DBMV, DBUV
DISPlay:CLEar	Clear measurement data and display
DISPlay:ENVELOPE	Enable the Envelope display mode. <Boolean> = 0, 1, ON, OFF
DISPlay:MODUlated:TIMEBASE	Set/return modulated timebase.
DISPlay: MODUlated:TSPAN	Set/return horizontal time span.Ex: <numeric_value>
DISPlay:PULSe:TIMEBASE	Set/return horizontal timebase. Ex: <numeric_value> = 0.05 sets timebase to 50 ms
DISPlay:PULSe:TSPAN	Set/return horizontal time span. Ex:<numeric_value> = 0.05 (50 ms)
DISPlay:[TEXt:]LIN:RESolution	Set number of significant digits for linear displays andremote return values. <numeric_value> = 3 to 5
DISPlay:[TEXt:]LOG:RESolution	Set number of decimal places for log displays and remote return values. <numeric_value> = 0 to 3
DISPlay:TRACe[1|2|3|4]:HOFFSet	Set/return the horizontal offset for statistical mode in dBr. <numeric_value> = -50.00 to +50.00 dBr
DISPlay:TRACe[1|2|3|4]:HSCALE	Set/return the horizontal scale for statistical mode in dB/Div. <numeric_value> = 0.1 to 5.0 dB/Div in 1-2-5 sequence
DISPlay:TRACe[1|2|3|4]:VCENTer	Change vertical center based on current units. Ex:<numeric_value> = 1.23
DISPlay:TRACe[1|2|3|4]:VSCALe	Change vertical scale based on current units. Ex:<numeric_value> = 20 set to 20dB/div (current units)
FETCh[1|2|3|4]:ARRay:AMEAsure:POWer?	Return current Ppeak, Pavgcyc, Pavgpulse, Ptop, Pbot, Overshoot
FETCh[1|2|3|4]:ARRay:AMEAsure:STATistical?	Return current Pavg, Ppeak, Pmin, PkToAvgRatio, CursorPwr, CursorPct, Sample-Count

Table 5-1. SCPI Command Summary (Continued)

FETCh[1|2|3|4]:ARRay:AMEAsure:TIMe?	Return current Freq, Period, Width, Offtime, Dcyc, Risetime, Falltime
FETCh[1|2|3|4]:ARRay:CW:POWer?	Return current Pavg, Pmax, Pmin, Ppulse or Pk/Avg
FETCh[1|2|3|4]:ARRay:MARKer:POWer?	Return current Pavg, Pmax, Pmin, P/Avg, Pmrk1, Pmrk2, Pmrk1/Pmrk2
FETCh[1|2|3|4]:CW:POWer?	Return current average reading in power units
FETCh[1|2|3|4]:INTERval:AVERage?	Return average power between MK1 and MK2.
FETCh[1|2|3|4]:INTERval:MAXFilt?	Return maximum filtered power between MK1 and MK2.
FETCh[1|2|3|4]:INTERval:MINFilt?	Return minimum filtered power between MK1 and MK2.
FETCh[1|2|3|4]:INTERval:MAXimum?	Return maximum instantaneous power between MK1 and MK2.
FETCh[1|2|3|4]:INTERval:MINimum?	Return minimum instantaneous power between MK1 and MK2.
FETCh[1|2|3|4]:INTERval:PKAVG?	Return peak to average power between MK1 and MK2.
FETCh[1|2|3|4]:MARKer[1|2]:AVERage?	Return current reading at the specified marker.
FETCh[1|2|3|4]:MARKer:DELTa?	Return difference between MK2 and MK1.
FETCh[1|2|3|4]:MARKer[1|2]:MAXimum?	Return maximum reading at the specified marker
FETCh[1|2|3|4]:MARKer[1|2]:MINimum?	Return minimum reading at the specified marker
FETCh[1|2|3|4]:MARKer:CURsor:PERcent?	Return percent at cursor.
FETCh[1|2|3|4]:MARKer:CURsor:POWer?	Return relative power at cursor.
FETCh[1|2|3|4]:MARKer:RATio?	Return ratio between MK2 and MK1 as a percentage.
FETCh[1|2|3|4]:MARKer:RDELTa?	Return difference between MK1 and MK2.
FETCh[1|2|3|4]:MARKer:RRATio?	Return ratio between MK1 and MK2 as a percentage.
FETCh[1|2|3|4]:MBUF:DATa:AVErage?	Return a partial list of Avg measurements from the last MBUF session
FETCh[1|2|3|4]:MBUF:DATa:AVErage:ALL?	Return a list of Avg measuremenst from the last MBUF session
FETCh[1|2|3|4]:MBUF:DATa:DURation?	Return a partial list of durations from the last MBUF session.
FETCh[1|2|3|4]:MBUF:DATa:DURation:ALL?	Return a list of durations from the last MBUF session.
FETCh[1|2|3|4]:MBUF:DATa:MAXimum?	Return a partial list of Max measurements from the last MBUF session
FETCh[1|2|3|4]:MBUF:DATa:MAXimum:ALL?	Return a list of Max measurements from the last MBUF session.
FETCh[1|2|3|4]:MBUF:DATa:MINimum?	Return a partial list of Min measurements from the last MBUF session
FETCh[1|2|3|4]:MBUF:DATa:MINimum:ALL?	Return a list of Min measurements from the last MBUF session.
FETCh[1|2|3|4]:MBUF:DATa:STARt?	Return a partial list of Start Times from the last MBUF session
FETCh[1|2|3|4]:MBUF:DATa:STARt:ALL?	Return a list of Start Times from the last MBUF session.
FETCh:TEMPerature:AVERage?	Return average internal instrument temperature in degrees C

Table 5-1. SCPI Command Summary (Continued)

FETch:TEMPerature:CURRent?	Return current internal instrument temperature in degrees C
INITiate:CONTinuous	Set/return state of mode which triggers meas cycles continuously. <Boolean> = 0, 1, OFF, ON
INITiate[:IMMediate[:ALL]]	Set mode which starts a measurement cycle when trigger event occurs
MARKer[1|2]:POSItion:TIMe	Set/return marker time relative to the trigger.
MARKer:POSItion:PERcent	Set or return the percent probability (y-axis-position) of the CCDF cursors. <numeric_value> = 0.000 to 100.0 %
MARKer:POSItion:POWer	Set or return the cumulative relative power (x-axis-position) of the CCDF cursors. <numeric_value> = 0.000 to 200.000
MEASure[1|2|3|4]:POWer?	Return Modulated Mode Pavg in dBm
MEASure[1|2|3|4]:VOLTage?	Return Modulated Mode Pavg in equivalent volts.
MEMory[1|2|3|4]:SNSR:CFFAST?	Return the sensor high bandwidth (FAST) frequency cal-factor table.
MEMory[1|2|3|4]:SNSR:CFSLOW?	Return the sensor low bandwidth (SLOW) frequency cal-factor table.
READ[1|2|3|4]:ARRay:AMEAsure:POWer?	Return new Ppeak, Pavgcyc, Pavgpulse, Ptop, Pbot, Overshoot
READ[1|2|3|4]:ARRay:AMEAsure:STATistical?	Return new Pavg, Ppeak, Pmin, PkToAvgRatio, CursorPwr, CursorPct, Sample-Count
READ[1|2|3|4]:ARRay:AMEAsure:TIMe?	Return new Freq, Period, Width, Offtime, Dcyc, Risetime, Falltime
READ[1|2|3|4]:ARRay:CW:POWer?	Return new Pavg, Pmax, Pmin, Ppulse or Pk/Avg
READ[1|2|3|4]:ARRay:MARKer:POWer?	Return new Pavg, Pmax, Pmin, P/Avg, Pmrk1, Pmrk2, Pmrk1/Pmrk2
READ[1|2|3|4]:CW:POWer?	Return new average reading in power units
READ[1|2|3|4]:INTERval:AVERage?	Return average power between MK1 and MK2.
READ[1|2|3|4]:INTERval:MAXFilt?	Return maximum filtered power between MK1 and MK2.
READ[1|2|3|4]:INTERval:MINFilt?	Return minimum filtered power between MK1 and MK2.
READ[1|2|3|4]:INTERval:MAXimum?	Return maximum instantaneous power between MK1 and MK2.
READ[1|2|3|4]:INTERval:MINimum?	Return minimum instantaneous power between MK1 and MK2.
READ[1|2|3|4]:INTERval:PKAVG?	Return peak to average power between MK1 and MK2.
READ[1|2|3|4]:MARKer[1|2]:AVERage?	Return new reading at the specified marker.
READ[1|2|3|4]:MARKer:DELTa?	Return difference between MK2 and MK1.
READ[1|2|3|4]:MARKer[1|2]:MAXimum?	Return maximum reading at the specified marker
READ[1|2|3|4]:MARKer[1|2]:MINimum?	Return minimum reading at the specified marker
READ[1|2|3|4]:MARKer:CURsor:PERcent?	Return percent at cursor.
READ[1|2|3|4]:MARKer:CURsor:POWer?	Return relative power at cursor.
READ[1|2|3|4]:MARKer:RATio?	Return ratio between MK2 and MK1 as a percentage.
READ[1|2|3|4]:MARKer:RDELTa?	Return difference between MK1 and MK2.

Table 5-1. SCPI Command Summary (Continued)

READ[1|2|3|4]:MARKer:RRATio?	Return ratio between MK1 and MK2 as a percentage.
SENSe[1|2|3|4]:AVERage	Set/return trace averaging count. <numeric_value> = 1 to 16384
SENSe[1|2|3|4]:BANDwidth	Set/return sensor video bandwidth. <character data> = LOW, HIGH
SENSe[1|2|3|4]:CORRection:CALFactor	Set correction factor in dB. <numeric_value> = -3.00 to 3.00
SENSe[1|2|3|4]:CORRection:DCYCle	Set/return duty cycle correction factor in percent. <numeric_value> = 0.01 to 100.0%
SENSe[1|2|3|4]:CORRection:FREQuency	Set channel frequency. <numeric_value> = 0.001e9 to 110.00e9 Hz
SENSe[1|2|3|4]:CORRection:OFFSet	Set/return sensor offset value in dB. <numeric_value> = -300 to 300
SENSe[1|2|3|4]:FILTer:STATe	Set/return filter state. <character data> = OFF, AUTO, ON
SENSe[1|2|3|4]:FILTer:TIMe	Set or return the current length of the integration filter on the selected channel. <numeric_value> = 0.002 to 16.000 seconds
SENSe:MBUF:ACQuire?	Start a new MBUF session
SENSe:MBUF:DELay:END	Set/return time added to end of burst for MBUF analysis.
SENSe:MBUF:DELay:STARt	Set/return time added to beginning of burst for MBUF analysis
SENSe:MBUF:ENABled:FLAG	Set/return bit mask indicating which arrays are filled during MBUF analysis.
SENSe:MBUF:GATe:MODe	Set/return gate mode used during MBUF analysis.
SENSe[1|2|2|3|4]:MBUF:MEASurements:AVAilable?	Return the number of measurements available for the specified channel.
SENSe:MBUF:MEASurements:CLEar	Clear cached avg, min, max, duration, start time, and sequence numbers taken during last MBUF session.
SENSe:MBUF:PERiod	Set/return period I seconds for timed mode MBUF measurements.
SENSe:MBUF:PERiod:DURation	Set/return duration in seconds for timed mode MBUF measurements.
SENSe:QUALifier:END	Set/return time power stays below trigger to count as end of burst in MBUF mode..
SENSe:QUALifier:STARt	Set/return time power stays above trigger to count as beginning of burst in MBUF mode.
SENSe:MBUF:SESsion:COUNt	Set/return the count of elements for arrays for MBUF analysis.
SENSe:MBUF:SESsion:TIMEout	Set/return the time in seconds for MBUF analysis.
SENSe:MBUF:START:MODe	Set/return the mode used to start acquiring MBUF entries.
SENSe[1|2|3|4]:PULSe:DISTal	Set/return distal parameter of the risetime. <numeric_value> = 50.00 to 100.00

Table 5-1. SCPI Command Summary (Continued)

SENSe[1|2|3|4]:PULSe:ENDGT	Set/return pulse gate end position in percent of pulse time duration. <numeric_value> = 60.00 to 100.00
SENSe[1|2|3|4]:PULSe:MESIal	Set/return mesial parameter of the risetime. <numeric_value> = 10.00 to 90.00
SENSe[1|2|3|4]:PULSe:PROXimal	Set/return proximal parameter of the risetime. <numeric_value> = 0.00 to 50.00 percent
SENSe[1|2|3|4]:PULSe:STARTGT	Set/return pulse gate start position in percent of pulse timeduration. <numeric_value> = 0.00 to 40.00
SENSe[1|2|3|4]:PULSe:UNIT	Set/return pulse definitions units. <numeric_value> = WATTS, VOLTS
SENSe[1|2|3|4]:SENSOR:TYPE?	Returns the sensor type for the selected channel. <character data> = NONE, CW, VOLT, PEAK
SYSTem:BEEP[:ENABle]	Set/return keypad audible beeper status. <Boolean> = 0, 1, OFF, ON
SYSTem:COMMunicate:GPIB:ADDRess	Set or return the GPIB bus address.<numeric_value> = 1 to 30
SYSTem:COMMunicate:LAN:ADDRess	Set or return the IP address for the Ethernet port. <character data> = instrument IP address in nnn.nnn.nnn.nnn (“dot decimal”) format
SYSTem:COMMunicate:LAN:DHCP[:STATe]	Set or return the state of DHCP/AutoIP system for the Ethernet port.<Boolean> = 0, 1, OFF, ON
SYSTem:COMMunicate:LAN:CURRent:ADDRess?	Returns the current IP address for the Ethernet port.
SYSTem:ERRor	Return system error code and description
SYSTem:ERRor[:NEXT]	Return system error code and description
SYSTem:ERRor:CODE	Return system error code
SYSTem:PRESet	Set instrument to default conditions.
SYSTem:VERSion?	Return SCPI version compliance. <numeric_value> = yyyy.v
TRACe[1|2|3|4]:[AVERage]:DATA[:NEXT]?	Return count min, max or average power samples starting at index
TRACe[1|2|3|4]:COUNt	Set/return total number of trace pwr points to return.<numeric_value> = 1 to 501
TRACe[1|2|3|4]:INDEX	Set/return index of the next trace power point. <numeric_value> = 0 to 500
TRIGger:CDF:COUNt	Set/return Statistical Mode terminal count. <numeric_value> = 1 to 4000 megasamples
TRIGger:CDF:DECImate	Set/return termination action when terminal count or time is reached. <character data> = { DECIMATE, RESTART, STOP}
TRIGger:CDF:TIMe	Set/return Statistical Mode terminal time. <numeric_value> = 1 to 3600 sec
TRIGger:DELay	Set/return trigger delay with respect to the trigger. <numeric_value> = see Specifications Section 1-6.
TRIGger:HOLDoff	Set/return trigger holdoff time. <numeric_value> = 0 to 1 sec in 10 ns increments

Table 5-1. SCPI Command Summary (Continued)

TRIGger:LEVel	Set/return trigger level. Internal Trigger: <numeric_value> = -40 to +20 dBm plus offset. External Trigger: <numeric_value> = ±5 volts
TRIGger:MODE	Set/return trigger mode on display. < character data > = AUTOPKPK, AUTO, NORMAL, FREERUN
TRIGger:POSition	Set/return trigger position on display. < character data > = LEFT, MIDDLE, RIGHT
TRIGger:SLOPe	Set/return trigger slope on display. <character data> = POS, NEG
TRIGger:SOURce	Select trigger source. < character data > = CH1, CH2, EXT
TRIGger:VERNier	Set or return the fine position of the trigger event on the displayed sweep. <numeric> -30 to +30

Chapter 6 — Automatic Measurements

6-1 Introduction

The ML2439A automatically analyzes the waveform data in the buffers and calculates key waveform parameters. The calculated values are displayed in text mode when you press the Text/graph system key. Measurement definitions are described in Table 6-1.

Table 6-1. Measurement Definitions

Text	TERM	DEFINITION
Width	Pulse Width	The interval between the first and second signal crossings of the mesial line.
Rise	Rise time	The interval between the first signal crossing of the proximal line to the first signal crossing of the distal line.
Fall	Fall time	The interval between the last signal crossing of the distal line to the last signal crossing of the proximal line.
Period	Pulse Period	The interval between two successive pulses (reciprocal of the Pulse Repetition Frequency).
PRFreq	Pulse Repetition Frequency	The number of cycles of a repetitive signal that take place in one second.
Duty C	Duty Cycle	The ratio of the pulse on-time to off-time.
Offtime	Off-time	The time a repetitive pulse is off (equal to the pulse period minus the pulse width).
Peak	Peak Power	The maximum power level of the captured waveform.
Pulse	Pulse Power	The average power level across the pulse width, defined by the intersection of the pulse rising and falling edges with the mesial line.
Oversh	Overshoot	A distortion following a major transition (the difference between the maximum amplitude of the overshoot and the top line).
Avg	Average Power	The equivalent heating effect of a signal.
IEEETop	Top Amplitude	The amplitude of the top line (see IEEE definitions).
IEEEBot	Bottom Amplitude	.The amplitude of the base line (see IEEE definitions).
Skew	Skew	The time between the mesial level of a pulse on one channel and a pulse on a second channel.
EdgeDly	Edge Delay	The time between the left edge of the display and the first mesial transition level of either slope on the waveform.
Rise	Rise-time	The interval between the first signal crossing of the proximal line to the first signal crossing of the distal line.

6-2 Automatic Measurement Sequence

The automatic measurement process analyzes the captured signal data in the following sequence:

1. Approximately 500 samples of the waveform (equivalent to one screen width) are scanned to determine the maximum and minimum sample amplitudes.
2. The difference between the maximum and minimum sample values is calculated and stored as the Signal Amplitude.
3. The Transition Threshold is computed as one-half the sum of the maximum and minimum sample amplitudes.
4. The processor locates each crossing of the Transition Threshold.
5. Starting at the left edge of the screen, the processor classifies each Transition threshold crossing according to whether it is positive-going (– +) or negative-going (+ –). Because the signal is repetitive, only three transitions are needed to classify the waveform as shown in Table 6-2.

Table 6-2. Transition Threshold

Type	Sequence	Description
0	none	No crossings detected
1		Not used
2	+ –	One falling edge
3	+	One rising edge
4	+ – +	One falling followed by one rising edge
5	– + –	One rising followed by one falling edge
6	+ – + –	Two falling edges
7	– + – +	Two rising edges

The Step waveforms are shown in Figure 6-1.

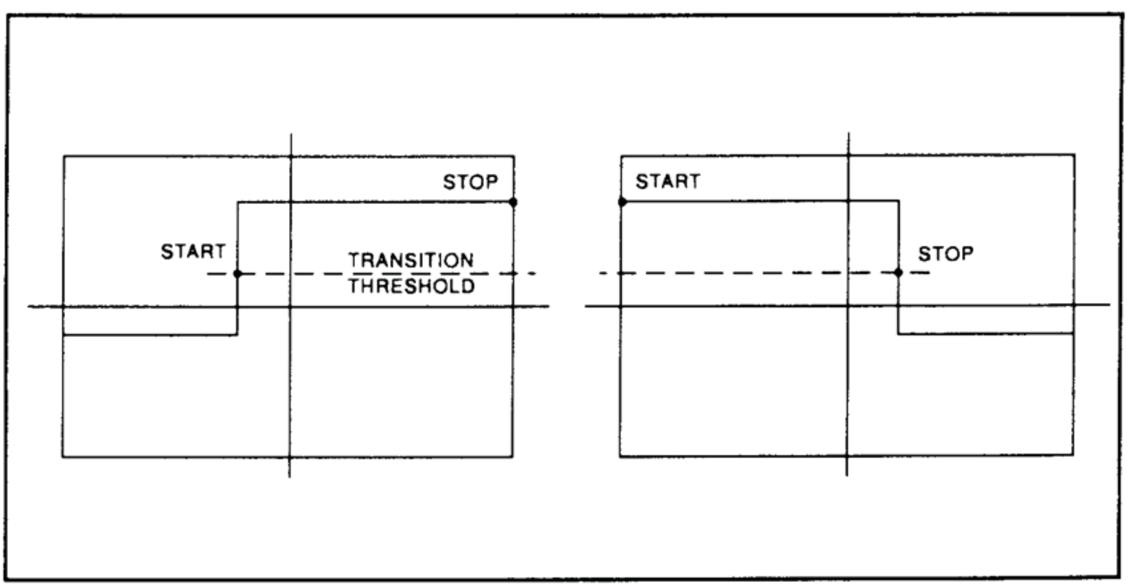


Figure 6-1. Step Waveforms

6. If the signal is Type 0, (No crossings detected) no measurements can be performed and the routine is terminated, pending the next reload of the data buffers.
7. The process locates the bottom amplitude (baseline) using the IEEE histogram method. A histogram is generated for all samples in the lowest 12.8 dB range of sample values. The range is subdivided into 64 power levels of 0.2 dB each. The histogram is scanned to locate the power level with the maximum number of crossings. This level is designated the baseline amplitude. If two or more power value have equal counts, the lowest is selected.
8. The process follows a similar procedure to locate the top amplitude (top line). The power range for the top histogram is 5 dB and the resolution is 0.02 dB, resulting in 250 levels. The level-crossing histogram is computed for a single pulse, using the samples which exceed the transition threshold. If only one transition exists in the buffer (Types 2 and 3), the process uses the samples that lie between the edge of the screen and the transition threshold as shown in Figure 6-2. For a level to be designated the top amplitude, the number of crossings of that level must be at least 1/16 the number of pixels in the pulse width; otherwise, the peak value is designated the top amplitude.
9. The process establishes the proximal, mesial, and distal levels as a percentage of the difference between top amplitude and bottom amplitude power. The percentage can be calculated on a power or voltage basis. The proximal, mesial, and distal threshold values are user settable from 1% to 99%, with the restriction that the proximal < mesial < distal. Normally, these values will be set to 10%, 50%, and 90%, respectively.
10. The process determines horizontal position, in pixels, at which the signal crosses the mesial value. This is done to a resolution of 0.1 pixel, or 1/5000 of the screen width. Ordinarily, the sample values do not fall precisely on the mesial line, and it is necessary to interpolate between the two nearest samples to determine where the mesial crossing occurred as shown in Figure 6-2.

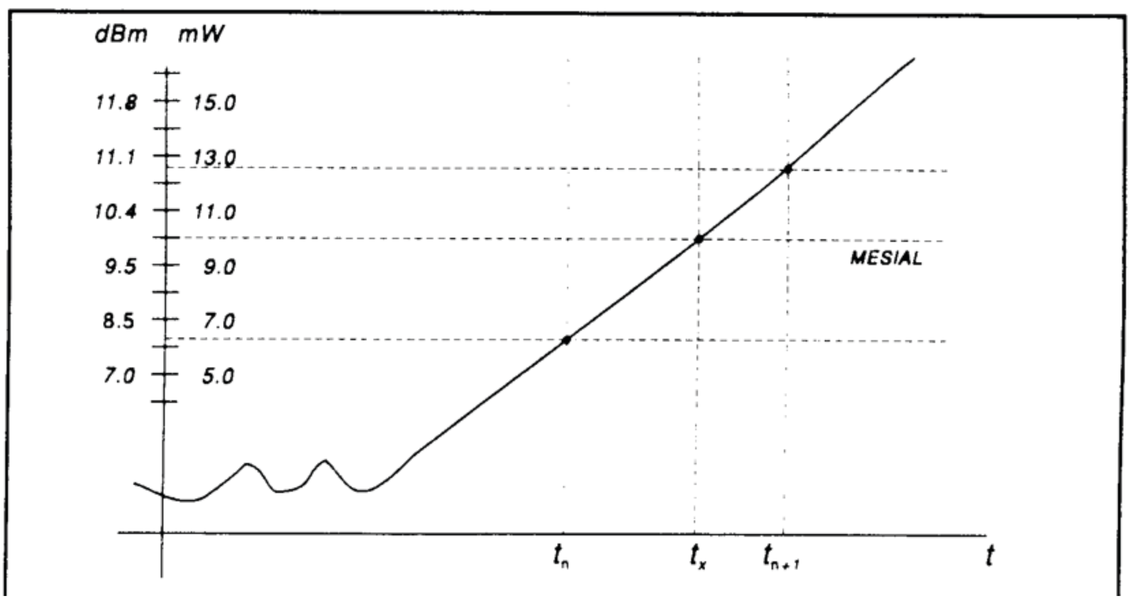


Figure 6-2. Time Interpolation

Table 6-3. Mesial Value

Item	dBm	mW
Mesial	value	10.0
Sample n	8.0	6.3
Sample n+1	11.0	12.6

The interpolated crossing time, tx, is calculated from:

$t_x = t_n + (P_{mes} - P_n)/(P_{n+1} - P_n)$

where P is in watts and n is the number of the sampling interval, referenced to the trigger event. For this example:

$t_x = t_n + (10.0 - 6.3)/(12.6 - 6.3)$

$t_x = t_n + 0.6$

The processor computes the rise and/or fall times of waveforms that meet the following conditions:
The waveform must have at least one usable edge (Step 2 through Step 7).

- The signal peak must be at least 13 dB greater than the minimum sample value.
- The rise time is defined as the time between the proximal and distal crossings (– +).

The fall time is defined as the time between the distal and proximal crossings (+ –).

If no samples lie between the proximal and distal values for either edge (rise or fall), the risetime for that edge is set to 0 seconds.

The processor calculates the output values according to the following definitions as described in Table 6-4.:

Table 6-4. Definitions

Pulse Width	Interval between mesial points
Rise time	See Step 11
Fall time	See Step 11
Period	Cycle time between mesial points
Pulse Repetition	Reciprocal of Period Frequency
Duty Cycle	Pulse Width/Period
Off-time	(Period) - (Pulse Width)
Peak Power	Maximum sample value. See Step 1
Pulse Power	Average power in the pulse (between the mesial points)
Overshoot	Peak Power) - (Top Amplitude)
Average Power	See Step 13
Top Amplitude	See Step 8
Bottom Amplitude	See Step 7
Skew	See Step 14

6-3 Average Power Over an Interval

1. The average power of the signal over a time interval is computed by:

- summing the sample powers in the interval
- dividing the sum by the number of samples

This process calculates Pulse Power, Average Power, and the average power between markers.

Since each sample represents the power ina finite time interval, the endpoints are handled separately to avoid spreading the interval by one-half pixel at each end of the interval as shown in Figure 6-3. The interval in Figure 6-3 the average power is given by:

P_{avg}= 1/2 (P_0+P_n)+1/((n-1)) $_{(n-1)}\Sigma_{(n-1)}P_n$

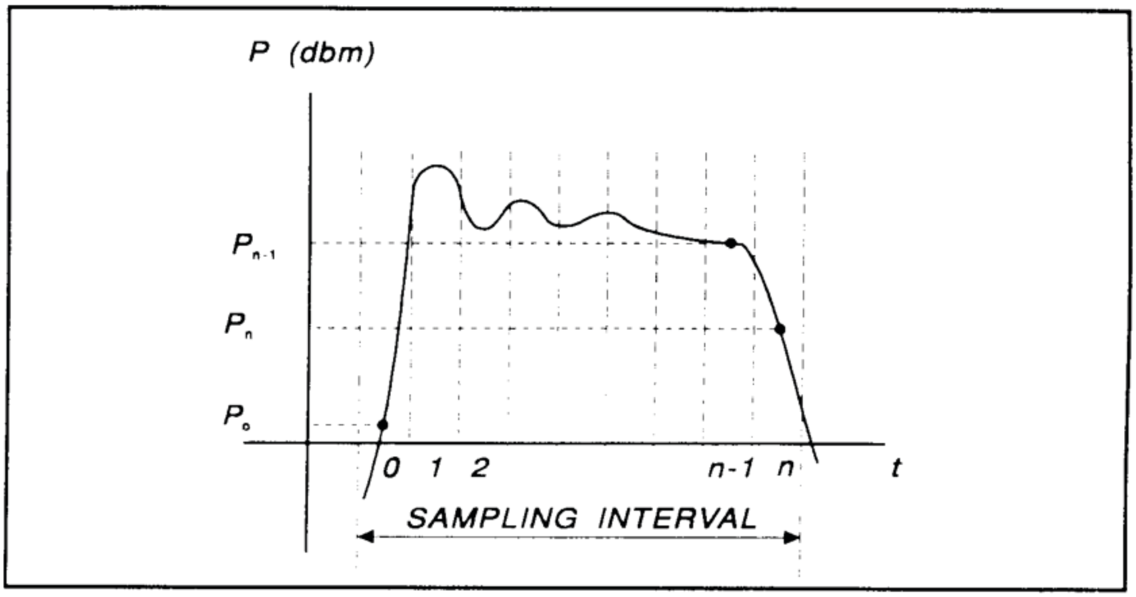


Figure 6-3. Sampling Intervals

2. The processor calculates the delay between the two measurement channels. The time reference for each channel is established by the first signal crossing (starting from the left edge of the screen) which passes through the mesial level. The signal excursion must be at least 6 dB.

6-4 Statistical Mode Automatic Measurements

When operating in Statistical mode, the ML2439A has a unique text format display that is available when the TEXT/GRAPH system key is pressed. A sample of the text display is shown in Figure 6-4.

Figure 6-4. Text Display Sample

In the Statistical mode the following five automatic measurements are displayed in the ML2439A Text display for both input channels and both trigger channels. The Text column lists the abbreviated forms that appear on the display screen.

Table 6-5.

Text	TERM	DEFINITION
Avg	Average Power	The unweighted average of all linear power samples occurring since acquisition started.
Peak	Peak Power	The highest power sample occurring since acquisition was started.
Min	Minimum Power	The lowest power sample occurring since acquisition was started. In logarithmic units a reading below the clip level will display as down arrows.
Pk2Avg	Ratio	The ratio (in dB) of the Peak Power to the Average Power.

The following six cursor measurements display the set position (independent variable) and measured value (dependent variables) where the movable cursor intersects the measurement trace. The position or value measurement text for each dependent variable is displayed in the color of its channel. The independent variable is white. Note that the intersection of the movable cursors and the CCDF traces can be moved outside the visible display area. This does not affect the measurements in any way

Table 6-6.

Text	TERM	DEFINITION
Cursor Pwr	Cursor Power	Cursor Mode - Power Ref
	Reference	The reference power level in dBr set by the user to define the measurement point on the normalized CCDF for probability in percent.
		Cursor Mode - Percent The measured power level in dBr of the normalized CCDF at the Probability in percent specified by the user.
Cursor Pct	Cursor Percentage	Cursor Mode - Power Ref The measured probability in percent of the normalized CCDF at the reference power level specified by the user.

The following two global status values are displayed:

Table 6-7.

Text	TERM	DEFINITION
Total	Time	The total time in Hours:Minutes:Seconds that the data acquisition has been running.
	Points	The total number of data samples in MSa that has been acquired for each channel in the current run.

Note	The total number of data samples is affected by the terminal settings. If Terminal Action is set to decimate, then the sample count will be halved each time the Terminal Count or Time is reached. This should have very little visible effect on the CCDF values, since the entire population is decimated uniformly. If Terminal Action is set to restart, then the sample count will be cleared to zero each time the Terminal Count or Time is reached.

6-5 Measurement Accuracy

The measurement accuracy of the ML2439A is completely contingent upon the USB sensor with which it is being used. Reference the sensor technical data sheet and/or associated uncertainty calculator for measurement uncertainties associated with a specific sensor.

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